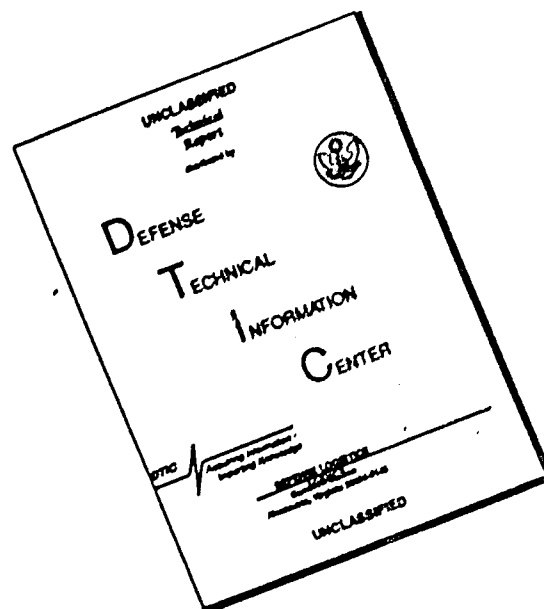


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AFOSR 700-III

**AIR FORCE SCIENTIFIC RESEARCH
BIBLIOGRAPHY
1959**

by

G. VERNON HOOKER
DORIS C. YATES
HARVEY D. BROOKINS
AARON S. DANN

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Office of Aerospace Research • United States Air Force
Washington, D.C. 20333
1965*

FOREWORD

The Air Force Office of Scientific Research, a primary research capability of the technology-dependent USAF, looks to the world of science with a view toward helping insure the most timely impact of new discovery on the operating capability of the Air Force. To this objective AFOSR brings to bear its specialized resources to assist the transfer of concepts from basic research to those agencies and individuals equipped to translate these concepts into technology.

One of the most comprehensive efforts of AFOSR in this direction is the Air Force Scientific Research Bibliography, a project designed and monitored by the AFOSR Directorate of Information Sciences. This series provides ready access to both the published literature and unpublished technical reports resulting from the extramural support of basic research by the Air Force.

Four years ago AFOSR published volume one covering research published from 1950 to 1956. Volume two, published in 1964, covers 1957 and 1958. This volume spans research published in 1959. Subsequent volumes now in preparation will make the bibliography effectively current.

The bibliography of this research stands as a unique publication among Federally sponsored research agencies, inasmuch as it sets forth a comprehensive listing of research results in one series. A large share of credit for the inclusiveness of the bibliography goes to the principal investigators through whose conscientious efforts the body of this literature has been collected.

This series is prepared through the cooperation of the Special Bibliographies Section of the Science and Technology Division, Library of Congress, which also prepared the scientific abstracts.



William J. Price
Executive Director

PREFACE

Epigraphs

"Another damned, thick, square book! Always scribe, scribe, scribe! Eh, Mr. Gibbon?" (1)

"We cannot think of scientific and technical information as dead records to be bundled up and stored away. It is perhaps a psychological error to speak in terms of 'storage'; if it can be stored, it is dead and its storage is a waste of time and effort. What we are dealing with is live and growing; it must be added to, adjusted, and--above all--kept where it can be reached, examined, used.

"...Storage, then, of documents, and their retrieval--as documents--offers no serious challenge to the librarians, the archivists, and the others concerned with collecting records. The difficulties arise in two subsequent concerns. One is letting potential users know that the documents are there; the other--harder--is letting them know what is in them." (2)

"Prerequisite to a solution of the problem (of information handling) is realistic recognition of information dissemination as a blood brother of experimentation in the R&D household. Acceptance and implementation of this principle will provide a logical, solid, and relatively permanent foundation on which to base the multitude of specific activities and studies that are essential to the eventual achievement of a sound, effective, overall U. S. scientific information system." (3)

Scope

This is the third volume of a continuing bibliographic series. The first volume, issued in 1961, covered the period 1950 through 1956. The second volume, issued in 1964, covered the period 1957 and 1958.

This volume of the bibliography includes, within the limitations of the law of diminishing returns, abstracts of all technical reports, journal articles, books, symposium proceedings, and monographs produced and published by scientists supported in whole or in part by the Air Force Office of Scientific Research during the calendar year 1959.

The Air Force Office of Scientific Research supports fundamental research in the five major scientific disciplines: physics, chemistry, engineering sciences (subsuming mechanics and propulsion), life sciences (both biological and behavioral, but not medical), and mathematics (including during the period of this bibliography, the information sciences). Thus, these abstracts are multi-disciplinary, their common link being their support by AFOSR.

Sources Searched

References, reports, and clues to the existence of reports were found by searching the indexes and report collection of the Air Force Office of Scientific Research Technical Library, and the collection of the Defense Documentation Center. Detailed searches were made of each contract file in the several AFOSR Directorates. In addition cover-to-cover searches were made of over 200 scientific journals issued mostly in the time period 1959-1962.

(1) Remark attributed to William Henry, Duke of Gloucester, upon presentation of the third volume of the "Decline and Fall of the Roman Empire."

(2) Study Number IV. "Documentation and Dissemination of Research and Development Results" Report of the Select Committee on Government Research of the House of Representatives. Eighty-eighth Congress, Second Session. 20 November, 1964. Page 91

(3) Gray, Dwight E. Science, v. 137: 266, July 27, 1962.

Form of Entry and Arrangement

Inherent in the organization of this book is the concept of the reports within a contract as an unanalyzed monographic series. Reports are posted chronologically and/or alphabetically under contracts, these in turn under laboratories, and these under contractors. This does, in fact, provide a rough subject grouping, with the detailed subject index leading into clusters of like reports.

The abstracts are identified by item numbers and are listed under these numbers in the indexes. The three letter mnemonic code, used in Volumes I and II, has been discontinued in this volume. The form of entry is, in general, that being used for DDC catalog cards, i.e.; source of the document; title; personal author, if any; date; pagination; report number; contract number; and accession number. The chief exception is that the primary entry is by the parent organization followed by the name of the specific laboratory or important subdivision, if necessary, e.g. Princeton U. Frick Chemical Lab., rather than Frick Chemical Lab., Princeton U.

Availability of Reports

The principal accession or control numbers, which indicate the locations of reports in collections are:

AD ASTIA Document, or Accessioned Document: available at DDC (Defense Documentation Center), Cameron Station, Alexandria, Virginia 22314

PB Publication Board: for sale by the Clearinghouse for Federal Scientific and Technical Information (CFSTI), Sills Building, 5285 Port Royal Road, Springfield, Virginia 22151

The fact that a report is abstracted in this book means that a copy of this report existed at the time the abstract was written; it should not be construed to imply that AFOSR or the Library of Congress necessarily has a copy available for distribution. Those seeking reports should do so from the cited agencies, not from AFOSR.

Indices

A detailed subject index, arranged alphabetically, and special subject classification for mathematics, have been provided. In addition, there are a contract index, an AFOSR control number index, and a personal author index.

Acknowledgements

Many people have shared in the production of this volume. The work has been fostered and encouraged by the previous Commanders and Executive Director of the Air Force Office of Scientific Research: Brigadier Generals H. F. Gregory and B. G. Holzman, Colonels A. P. Gagge and Jack L. Deets, Dr. Knox Millsaps and the present Executive Director, Dr. William Price. Invaluable assistance has been given by Mrs. Eleanor Capps, AFOSR's documentation librarian, whose accurate records have helped to make this book possible. Alex Nagy, chief designer, and staff artist of the Office of Aerospace Research drew the chapter end plates (with the usual disclaimer about resemblances to persons living or dead being purely coincidental). Perhaps, most important of all, has been the cheerful and willing cooperation of the scientific staff of AFOSR in assisting the bibliographers in locating reports and helping with subject analysis.

The bibliographic team has worked under the guidance and leadership of Dr. Clement R. Brown, Head of the Special Bibliographies Section, Science and Technology Division, Library of Congress. The chief bibliographers have been G. Vernon Hooker, Aaron S. Dann, Doris C. Yates and Harvey D. Brookins. A special note of gratitude is due to those who have aided in abstracting and subject indexing, especially Thomas C. Goodwin, Mrs. Joan Halpin, Abbott W. Martin, Jr., and Bruce Blankenhorn. Recognition is also due for the invaluable work in the preparation of this manuscript done by Mrs. Marion S. Carr and Mrs. Phyllis M. Martin.

This bibliographic task has been supported and monitored by the Information Sciences Directorate, AFOSR, as part of a continuing research program to study and devise new and better ways of handling scientific and technical information.

Harold Wooster

Washington, D. C.
August 1965

Harold Wooster
Director
Information Sciences

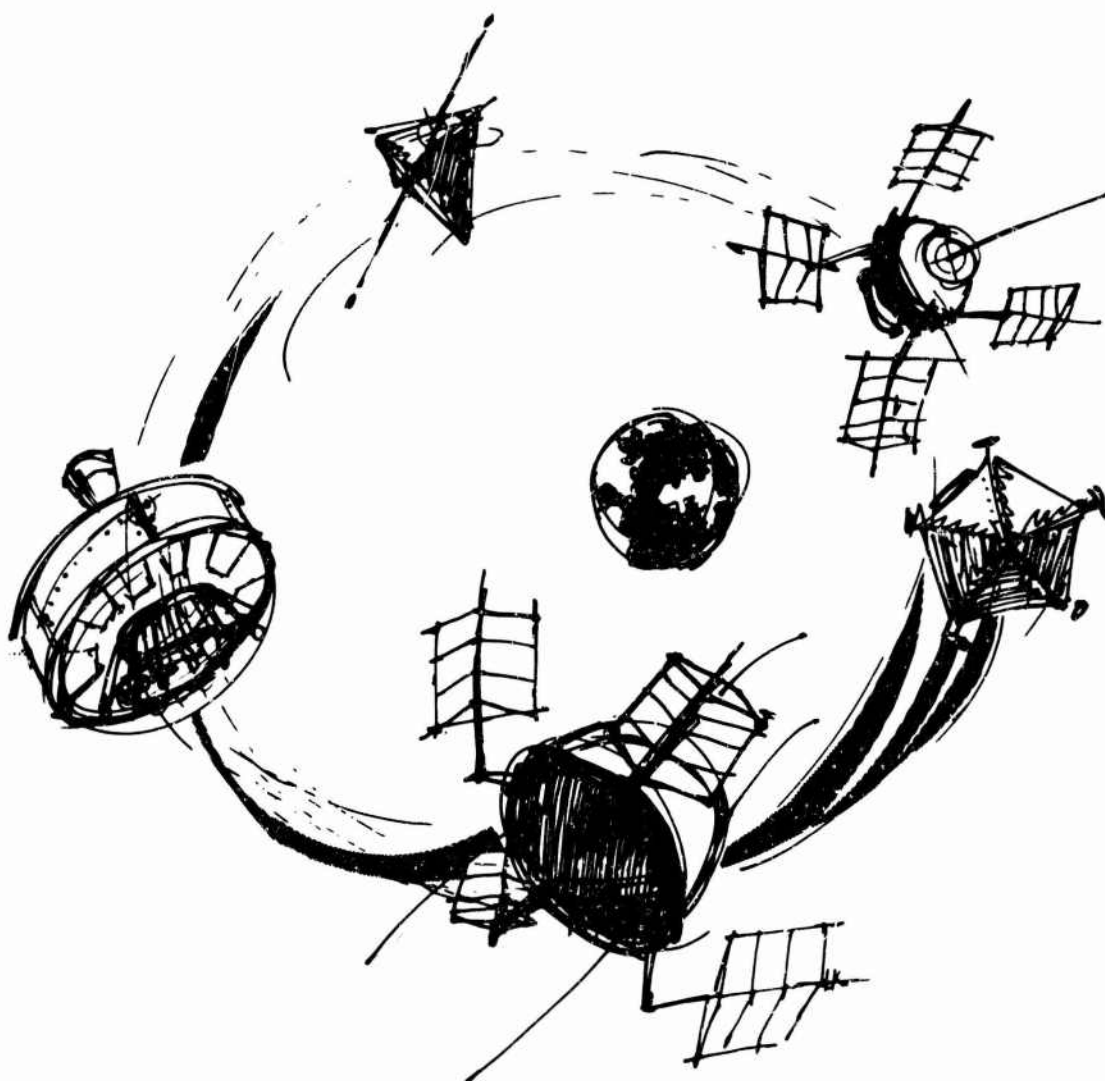


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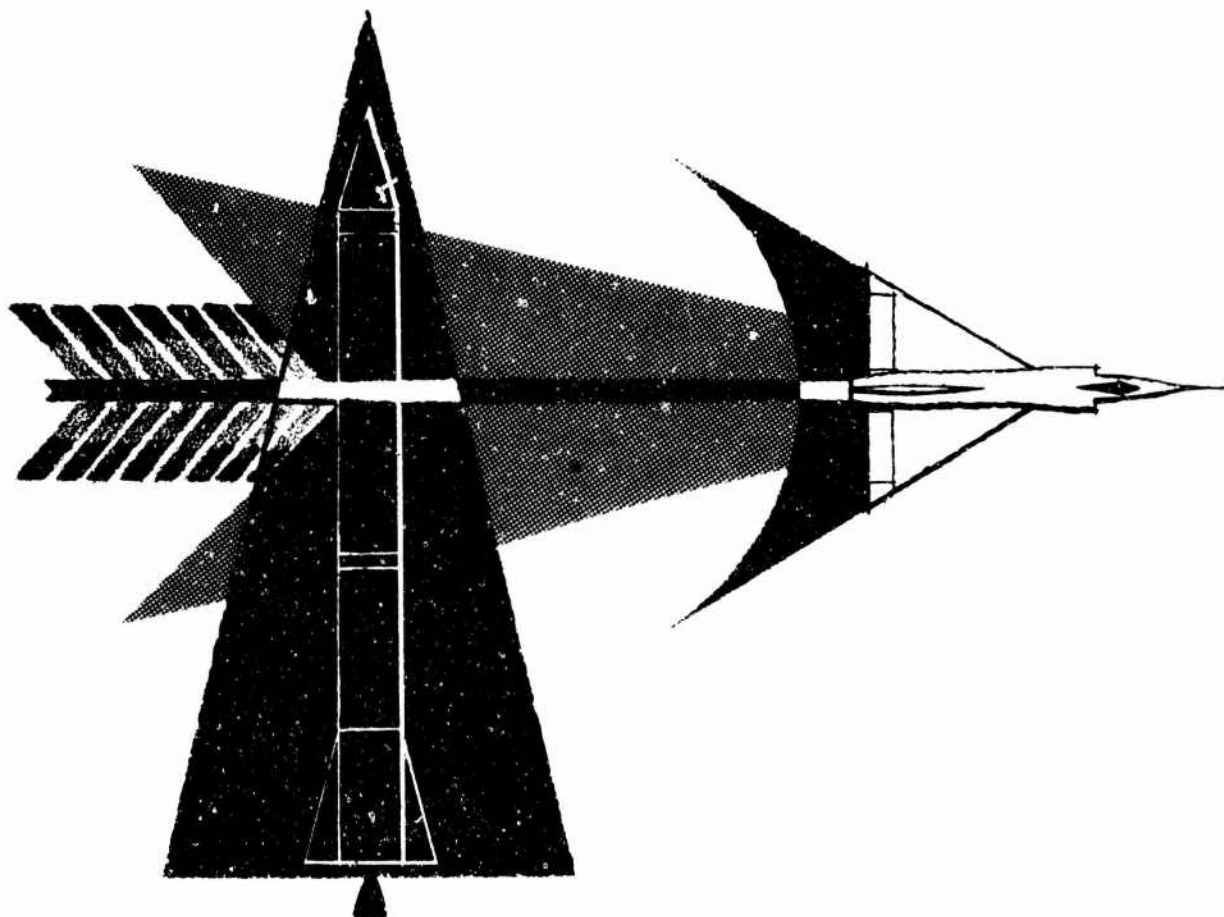
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1

Aarhus U. [Mathematical Inst.] (Denmark).

ON THE DISTRIBUTION OF THE RANDOM VARIABLE H_n , by E. S. Andersen. Feb. 27, 1959 [15]p. incl. diagr. (Technical scientific note no. 1) (AFOSR-TN-59-671) (AF 61(052)42) AD 218383 Unclassified

Treatment is made of the distribution of the random variable H_n . Given a sequence X_1, X_2, \dots of random variables we define $S_k = X_1 + \dots + X_k$ and the new sequence $T_0^{(n)}, T_1^{(n)}, \dots, T_n^{(n)}$ as the largest convex minorant sequence to the sequence $S_0 = 0, S_1, \dots, S_n$. The random variable H_n we define as the number of values $k (k = 1, \dots, n)$ for which $T_k^{(n)} = S_k$. It is assumed that the random variables X_1, X_2, \dots are independent and identically distributed. In the case, where the common distribution function $F(x)$ of the random variables X_n is continuous the distribution of H_n is known. The condition that $F(x)$ be continuous is omitted. The main result is a formula for the double-generating function

$$H(s, t) = \sum_{n=0}^{\infty} \sum_{m=0}^n P(H_n = m) s^n t^m.$$

(Contractor's abstract)

2

Aarhus U. [Mathematical Inst.] (Denmark).

ON THE DISTRIBUTION OF THE RANDOM VARIABLE H_n , by E. S. Andersen. Technical summary rept. Feb. 27, 1959 [4]p. (AFOSR-TN-59-672) (AF 61(052)42) AD 218384 Unclassified

Definition of the random variable H_n is presented. Given a sequence of random variables X_1, X_2, \dots , $S_k = X_1 + \dots + X_k$ and a new sequence $T_0^{(n)}, T_1^{(n)}, \dots, T_n^{(n)}$ is defined as the largest convex minorant sequence to the sequence $S_0 = 0, S_1, \dots, S_n$. The random variable H_n is defined as the number of values $k (k = 1, \dots, n)$ for which $T_k^{(n)} = S_k$. The distribution of H_n was investigated under the assumption that the random variables X_1, X_2, \dots are independent and identically distributed. If the common distribution function $F(x)$ of the random variables X_k is continuous, then the distribution of H_n is known. In the investigations reported the condition that $F(x)$ be continuous was

dropped. The main result is a formula for the double-generating function

$$H(s, t) = \sum_{n=0}^{\infty} \sum_{m=0}^n P(H_n = m) s^n t^m.$$

(Contractor's abstract)

3

AeroChem Research Labs., Inc., Princeton, N. J.

SIMILITUDE TREATMENT OF HYPERSONIC STAGNATION HEAT TRANSFER, by D. E. Rosner. [1959] [2]p. [Rept. no. TP-10] (AFOSR-TN-59-228) (AF 49(638)-300) AD 212920 Unclassified

Also published in ARS Jour., v. 29: 215-216, Mar. 1959.

Using the similarity between heat and mass transport an expression for the convective heat transfer rate at the nose of a blunt body is developed for dissociated but chemically frozen laminar flow with arbitrary surface catalytic activity. The result is shown to be identical in structure with recent solutions to the boundary layer equations.

4

AeroChem Research Labs., Inc., Princeton, N. J.

REACTION RATE DISTRIBUTIONS ON CATALYTIC SURFACES, by D. E. Rosner. Dec. 26, 1958 (7)p. incl. diagrs. (Rept. no. TM-12) (AFOSR-TN-59-432) (AF 49(638)300) AD 214794; PB 140809 Unclassified

Ambrok's (Soviet Phys. Technical Phys., v. 2: 1979-1986, Sept. 1957) nonsimilarity correction to the Nusselt number is applied to the diffusion boundary layer with catalytic surface reaction. For the laminar boundary layer on a catalytic flat plate closed form results are obtained for the steady state reactant concentration along the surface and hence the reaction rate distribution, for arbitrary values of the reaction order. (Contractor's abstract)

5

AeroChem Research Labs., Inc., Princeton, N. J.

ON THE EFFECTS OF DIFFUSION AND CHEMICAL REACTION IN CONVECTIVE HEAT TRANSFER, by D. E. Rosner. (Rept. no. TM-13) (AFOSR-TN-59-920) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)300 and Wright Air Development Center under AF 33(616)6216) Unclassified

Also published in ARS Jour., v. 30: 114-115, Jan. 1960.

The notion of an "effective" thermal conductivity for reacting gaseous mixtures is applied to the prediction

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of convective heat transfer rates when dissociation, diffusion and atom recombination take place within a laminar boundary layer in quasi-equilibrium. The result for the forward stagnation region of a cool blunt nosed body is compared to recent solutions of the boundary layer equations with particular regard to the explicit dependence on the Lewis number. (Contractor's abstract)

6

AeroChem Research Labs., Inc., Princeton, N. J.

CHEMICALLY FROZEN BOUNDARY LAYERS WITH CATALYTIC SURFACE REACTION, by D. E. Rosner. [1959] [6]p. incl. diagrs. refs. (AF 49(638)300)

Unclassified

Published in Jour. Aero/Space Sci., v. 26: 281-286, May 1959.

When a fluid boundary layer containing a single reactant develops along a solid surface which acts chemically as a sink distribution for this species, its steady-state concentration along the surface, and, hence, the reaction rate distribution depends both upon the true surface chemical kinetics and a combination of convective and diffusive mass transport through the fluid. A simple approx method for studying this streamwise distribution of reaction rate in terms of the shear and temperature distributions along the surface. The method is based upon a treatment of the concentration integral equation which initially parallels Liepmann's recent treatment of the energy integral equation but which ultimately leads to a differential equation for the concentration distribution of reactant along the surface. This approach to "mass transfer" problems is compared with the techniques of Chambré and Acrivos. The reactant concentration is considered to be so small that constant diffusion coefficient, D , viscosity coefficient, μ , Prandtl Number for diffusion (Schmidt Number), $Pr_D = \mu/(pD)$, can be assumed, and the fluid is taken to be incompressible, with catalyzed reaction taking place only at the wall. Thus, the hydrodynamic field is unaltered by the surface reaction, and only the effect of small surface temperature differences on the kinetics of the wall reaction — i.e., the effective "sink" strength — are taken into account. Extension to the case of several reactants is discussed, and an interpretation of the governing catalytic parameter as a ratio of characteristics times is given. (Contractor's abstract, modified)

7

AeroChem Research Labs., Inc., Princeton, N. J.

LOW TEMPERATURE PLASMA JET AS A FREE RADICAL SOURCE (Abstract), by D. E. Rosner, H. Burwasser, and H. F. Calcote. [1959] [1]p. (Bound

with its AFOSR-TN-59-770; AD 241053) (AF 49(638)-300)

Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Nitrogen at pressures between 30-100 mm Hg has been partially dissociated in a dc discharge and expanded through a split brass/lava nozzle-shaped cathode into a low pressure (1-10 mm) test section. Power balance and discharge characteristics have been obtained over a current range from 0.25-0.50 amp at fixed electrode separation. In addition to an over-all power balance technique, 2 methods are described for determining the atom concentration in the emerging supersonic jet of active nitrogen. The 1st is a differential thermoelectric catalytic probe technique relying on the difference in the catalytic activity of 2 small cylinders in cross flow to the exothermic surface recombination of atoms. The theory of such probes in low density supersonic flows is discussed with regard to corrections for arbitrary catalytic activity, diffusion and radiation. In practice, platinumized quartz and bare quartz have been used as the catalytic and "noncatalytic" members, with both elements operating in the slip flow regime. The 2nd method consists of a chemical titration in which propylene is used as the titrant, and the amount of hydrogen cyanide produced by the reaction with nitrogen atoms is determined by means of mass spectrometric analysis. Based on the measurements made to date, the over-all energy efficiency for the production of atoms by the device described compares favorably with high intensity arc plasma jets operating at stagnation temperatures in excess of 6000°K.

8

Aerojet-General Corp., Azusa, Calif.

KINETICS OF THE SURFACE DEGRADATION OF POLYMETHYLMETHACRYLATE, by R. F. Chaiken, W. H. Andersen and others. Aug. 1959 [15]p. incl. diagrs. tables, refs. (Rept. no. TN-29) (AFOSR-TN-59-610) (AF 18(603)74) AD 217397

Unclassified

Also published in Jour. Chem. Phys., v. 32: 141-146, Jan. 1960.

The surface degradation of both linear and crosslinked polymethylmethacrylate (PMM) has been studied over the surface temperature range from 550 to 910°K by means of a hot-plate pyrolysis technique. It was demonstrated that surface gasification due to the high heat flux at the decomposing PMM surface involves a depolymerization process and surface desorption of methylmethacrylate monomer. The apparent activation energy for the linear rate of regression of the solid PMM surface (linear pyrolysis rate) was found to decrease with increasing surface temperature, approaching a limiting constant value of 11.2 ± 0.6 kcal/mol at $\sim 650^\circ\text{K}$

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for linear PMM, and at $\sim 770^\circ\text{K}$ for crosslinked PMM. The mechanism for the surface degradation is depicted as (1) formation of monomer in the surface substrate, (2) diffusion of monomer to the surface, and (3) desorption of monomer from the surface. The linear-pyrolysis-rate data is correlated by means of an absolute-rate-theory treatment of surface decomposition. The experimental results are in good agreement with the theory. (Contractor's abstract)

9

Aerojet-General Corp., Azusa, Calif.

STUDY OF THE KINETICS OF SOLID PHASE REACTIONS, by R. F. Chaiken. Nov. 1959, 6p. incl. refs. (Rept. no. 1706) (AFOSR-TR-59-180) (AF 18(603)74) AD 229120 Unclassified

A theoretical concept of the mechanism of the thermal decomposition of solids proposed by Schultz and Dekker was tested on various pure compounds. Mechanisms are postulated for the degradation of polymethylmethacrylate and the decomposition of ammonium nitrate. Important differences were found between bulk and surface decomposition data which could be explained on the basis of the processes involved. An improved linear pyrolysis apparatus was constructed which permitted the re-evaluation of kinetic data. A careful study of the data revealed the limitations of the instrument, and resulted in the use of supplementary methods for obtaining kinetic decomposition data. (Contractor's abstract)

10

Aerojet-General Corp., Azusa, Calif.

A MODEL DESCRIBING COMBUSTION OF SOLID COMPOSITE PROPELLANTS CONTAINING AMMONIUM NITRATE, by W. H. Andersen, K. W. Bills and others. [1959] [17]p. incl. diagrs. tables. (AF 18(603)-74) Unclassified

Published in Combustion and Flame, v. 3: 301-317, Sept. 1959.

A 'two-temperature' model describing the burning of ammonium nitrate, AN, composite propellants is presented. This theory postulates that in an AN propellant, the oxidizer gasifies first at about 300° to 350°C by a highly endothermic surface process to give premixed ammonia and nitric acid. The oxidation-reduction reactions of these 2 gases establish a flame with a maximum temperature of about 1000°C . Burning catalysts influence burning characteristics of AN propellants mainly through a heterogeneous catalysis of these gas-phase reactions. Particles of binder protrude from the burning oxidizer surface and pyrolyse in this hot flame-zone. Since the pyrolysis of solid oxidizer and of solid binder are independent processes it is possible with this theory to estimate average surface temperatures of both

the oxidizer and binder in the burning propellant by means of linear pyrolysis-rate data. Unique experiments demonstrate that the binder-oxidizer gas reactions often take place at a relatively large distance from the surface in a region of relatively high temperature. The heat produced by these exothermic binder-oxidizer gas reactions (diffusion flame) must therefore contribute very little to the determination of the effective temperature at the surface with many typical AN propellants. The theory predicts a lower limit of about 0.04 cm/sec to the burning rate of AN propellants. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

A THERMAL LAYER MECHANISM OF COMBUSTION OF SOLID COMPOSITE PROPELLANTS: APPLICATION TO AMMONIUM NITRATE PROPELLANTS, by R. F. Chaiken. [1959] [16]p. incl. diagrs. refs. (AF 18-(603)74) Unclassified

Published in Combustion and Flame, v. 3: 285-300, Sept. 1959.

A mechanism for the combustion of ammonium nitrate solid composite propellants is present, utilizing the recent 'two-temperature' theory of propellant burning. According to the theory, the rate-controlling reactions associated with the gasification (pyrolysis) of the solid oxidizer and of the solid binder in a composite propellant are essentially independent of each other. A model of steady-state combustion is set up which considers the pyrolysis of oxidizer separately from the binder. It is assumed that the surface pyrolysis is the result of the transfer of heat from a flame zone surrounding the oxidizer particle, and that this flame zone is the result of the gas-phase redox reactions between the oxidizer pyrolysis products. It is assumed that a thermal layer exists about an oxidizer particle; the thickness of this layer (distance between the oxidizer surface and the flame zone) is related to the velocity at which gas expands away from the surface, and the rate of the gas-phase reaction. From heat transfer considerations, an analytical expression for the thickness of the thermal layer is obtained in terms of the pressure, oxidizer particle size, and the kinetics of the solid and gas-phase reactions. The agreement between the theory and the available data on ammonium nitrate propellants is reasonable. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

A THERMOCOUPLE JUNCTION FOR A HOT-PLATE LINEAR PYROLYSIS APPARATUS, by R. F. Chaiken and D. K. Van de Mark. [1959] [4]p. incl. diagr. (AF 18(603)74) Unclassified

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Published in Rev. Scient. Instr., v. 30: 375-376, May 1960.

As a supplement to a previous report (AER.06:001, Vol. II) it is pointed out that the surface temperature measurements given could be in error, particularly at high heat flux. The finite thickness of the thermocouple junction is believed to be the cause of the error. At lower temperatures the temperature drop across the plate is small and negligible, but at higher temperatures the drop is quite noticeable. Surface temperature measurements which are in error by as much as 30°C have been found.

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Aerojet-General Corp., Azusa, Calif.

FREE RADICAL FUELS - A TOUGH PROBLEM, by J. M. Flournoy. Sept. 1959 [6]p. incl. illus. diagr. (Rept. no. TN-32) (AFOSR-TN-59-821) (AF 18(603)-110) AD 226541 Unclassified

Also published in Astronautics, v. 4: 44, 106, 1959.

The problems involved in the use of stabilized energetic free radicals for propulsion purposes are summarized and discussed briefly in terms of 4 problem areas: selection of systems, production, storage, and combustion. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

CHEMICAL FRAGMENTS AS ULTRA-ENERGY PROPELLANTS, by D. L. Wulff, I. H. Baum, and J. M. Flournoy. Nov. 1959, 56p. incl. refs. (Abstracts Bull. no. 4; rept. no. TN-53) (AFOSR-TN-59-1249) (AF 18(603)110) AD 230736; PB 145649 Unclassified

The 4th in a series of Abstracts Bulletins continuing the work of the 1st 3 (AER.08:001, 002, 004, Vol. II) surveys the time period from 1956 through part of 1958. This bulletin is expected to terminate the service since wide-spread interest in this field has been generated. The investigations cover certain high-energy chemical systems as potential propellants for rocket propulsion which has necessitated an extensive review of the literature concerned with chemical fragments, products, identification, stabilization, and determination of properties.

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Aerojet-General Corp., Azusa, Calif.

RESEARCH ON ULTRA ENERGY FUELS FOR ROCKET PROPULSION, by J. M. Flournoy, L. H.

Baum and others. Oct. 1959, 1v. incl. illus. diagrs. tables, refs. (Rept. no. 1690) (AFOSR-TR-59-169) (AF 18(603)110) AD 229132 Unclassified

The results of 3 yr of research on the stabilization of energetic free radicals are summarized. Hydrogen atoms, hydroxyl radicals, and other normally unstable chemical species, produced by ionizing radiation and by electric discharges, were stabilized at low temperatures. The rate of disappearance of some of these radicals were studied over a range of temperatures, using electron-paramagnetic-resonance techniques. The heat released by the recombination of hydroxyl radicals in ice near 100°K was measured. The adsorption of hydrogen atoms on glassy materials at normal temperatures was investigated and found to involve a variety of different adsorption sites. The general problems involved in the production, storage, and utilization of high concentrations of free radicals are briefly summarized in the light of the results of research in the field over the last several years. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

RESEARCH ON FREE RADICALS AS ROCKET PROPELLANTS, by G. Moe and D. L. Armstrong. [1959] [14]p. incl. diagrs. tables, refs. [AF 18(603)110] Unclassified

Published in Proc. Symposium on Advanced Propulsion Systems, Los Angeles, Calif. (Dec. 11-13, 1957), New York, Pergamon Press, v. 2: 213-226, 1959.

One of the problems encountered in the development of airborne vehicles capable of traveling longer distances and of attaining increased altitudes is the need for fuels of higher specific impulse than is currently attainable with conventional chemical fuels. Calculations have been made to indicate that significant increases in the performance of rocket propellants are possible if certain types of free radicals and atoms can be utilized. The radicals and/or atoms might be introduced into a suitable working fluid, such as hydrogen. The reaction of the radicals would heat the working fluid to the desired operating temperature. Whereas the maximum specific impulse that can be expected from ordinary chemical propellant systems is in the range from 350 to 400 lb-sec/lb, the utilization of the heat of reaction of free radicals, such as NH, CH, or of atomic H could result in specific impulses in excess of 400 lb-sec/lb. The method of calculation of the performance characteristics of free radical propellant systems is discussed in detail. The results of an experimental study on the production and stabilization of the imine radical, NH indicate that the blue material which is condensed at -196°C when hydrazoic acid, HN₃, is passed through a furnace at 1000°C or an electric discharge is a form of undissociated hydrazoic acid. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

EPR STUDIES OF ELECTRON IRRADIATED ICE AND SOLID HYDROGEN, by J. M. Flournoy, L. H. Piette and others. [1959] [2]p. incl. diagrs. [AF 49(638)110] Unclassified

Published in Jour. Chem. Phys., v. 30: 1623-1624, June 1959.

The results are given of a group of electron irradiation experiments employing the Stanford U. mark II 40-mev linear accelerator and a V-4500 EPR spectrometer with liquid helium accessory. Irradiations were carried out on ice and on solid hydrogen. Resonance values were obtained at 4.2°K at different dosages and reported. It is felt that increased concentration of the hydrogen atom could be achieved through improved thermal contact of the sample to the helium bath and through the use of considerably lower irradiation rates.

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Aerojet-General Corp., Azusa, Calif.

UTILIZATION OF UPPER-ATMOSPHERE ATOMIC-OXYGEN RECOMBINATION FOR PROPULSION, by A. Zukerman and C. B. Kretschmer. Apr. 10, 1959, 1v. incl. diagrs. tables, refs. (Rept. no. TN-28) (AFOSR-TN-59-517) (AF 49(638)111) AD 216292; PB 152055 Unclassified

The report presents a preliminary investigation of several methods for the utilization of the upper-atmosphere atomic-oxygen recombination energy for propulsion purposes. The following systems were studied: (1) the fuelless ramjet, (2) a ramjet with fuel addition, and (3) a catalytic ram rocket (a power plant of the ramjet type in which the chemical reaction takes place primarily on the catalytic surfaces of the reaction chamber). The fuelless ramjet cycle was previously investigated using ideal conditions (AER.11:004, Vol. II). In this investigation, losses were taken into account and the latest available values for the reaction-rate constant were used. This investigation shows that the fuelless ramjet cannot provide enough thrust to sustain a satellite in the atomic-oxygen layer. The investigation of the ramjet with mass addition shows that with fuels similar to NO₂ (in molecular weight and heat release) enough thrust can be derived to overcome the external drag, but not the total drag. Certain configurations of the catalytic ram rocket show promise for sustaining a satellite for a considerable length of time at a high expense of coolant fluid. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

A STUDY OF THE FEASIBILITY OF AN ATOMIC OXYGEN RAMJET, by A. Zukerman and C. B. Kretschmer. [1959] [17]p. incl. diagrs. tables. [AFOSR-TN-59-820] [AF 49(638)111] Unclassified

Presented at Fourth AFBMD/STL Symposium on Advances in Ballistic Missile and Space Technology, Los Angeles, Calif., Aug. 24-27, 1959.

Also published in Planetary and Space Sci., v. 4: 60-76, Jan. 1961.

The utilization of the upper-atmosphere, atomic-oxygen-recombination energy for propulsion purposes through the use of different ramjet types of engine was investigated. The fuelless ramjet, the ramjet with fuel addition, and a catalytic-ramjet-rocket (ram-rocket) were investigated as possible satellite sustainers in the atomic-oxygen layer. Optimum configurations of the different types were determined, and the performance was compared with satellite sustaining requirements. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

INVESTIGATION OF ATOMIC-OXYGEN RECOMBINATION RATES, by C. B. Kretschmer. Final rept. May 1959 [35]p. incl. diagrs. table, refs. (Rept. no. 1611) (AFOSR-TR-59-82) (AF 49(638)111) AD 217008 Unclassified

The following values of rate constants were determined at 350°K:

$O + O + M \rightarrow O_2 + M$; $k_1 = (2.5 \pm 1.0) \times 10^{15} \text{ cm}^6/\text{mol}^2 \text{ sec}$

$O + O_2 + M \rightarrow O_3 + M$; $k_2 = 1.1 \times 10^{14} \text{ cm}^6/\text{mol}^2 \text{ sec}$

$O + OH + M \rightarrow H_2O + M$; $k_{28} = 1.2 \times 10^{17} \text{ cm}^6/\text{mol}^2 \text{ sec}$

These values are for $M = O_2$ or A. When $M = O$, k_1 is 4 to 20 times as large as the value stated. A comparison of the value of k_1 found here with values obtained from shock-tube experiments gives the following equation for the temperature dependence of k_1 : $k_1 =$

$10^{14} (T/4500)^{-(1.22 \pm 0.16)} \pm 5 \times 10^{13} \text{ cm}^6/\text{mol}^2 \text{ sec}$.

An investigation of the feasibility of the atomic-oxygen ramjet led to the conclusion that flight at orbital velocity is impossible because of diffuser losses. Flight at $M = 2$ is marginally feasible, but at any velocity less than orbital, the payload capacity is essentially zero.

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Aerojet-General Corp., Azusa, Calif.

POSITIVE-ION EMISSION FROM SURFACES (Abstract), by R. J. Sunderland. [1958] [1]p. (Bound with its AFOSR-TR-58-125; AD 162274; also bound with its AFOSR-TN-59-770, AD 241053) (AF 49(638)214)

Unclassified

Presented at Conf. on Ion and Plasma Research, Maryland U., College Park, Sept. 30-Oct. 2, 1958.

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

At the present time there does not exist a source capable of producing a copious quantity of ions on a surface and which also has the feature of continuously replenishing the ionizing material. The research being conducted under this contract is directed toward the investigation of several systems which show promise of providing the desired emissions. These include: (1) the ionization of gases on diffusion through heated metal foils, (2) the electrolysis of alkali metal ions through glass membranes, and (3) the diffusion of alkali metal vapor through porous tantalum or tungsten metals at elevated temperatures. The sodium through glass experiment is the most advanced, and there is some indication of an emission from the vacuum side of a glass membrane whose outer surface is immersed in a molten sodium nitrate bath. The emitted material is collected on a water cooled surface maintained at a high negative potential with respect to the molten salt. Apparatus for the detection and identification of the ions emitted from a heated palladium foil through which hydrogen is diffusing has been designed and is being assembled, and a device to study the transmission of cesium vapor through a porous tungsten sheet maintained at 1200-1400°K is being fabricated.

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Aerojet-General Corp., Azusa, Calif.

THEORETICAL AND EXPERIMENTAL STUDIES OF GAS DYNAMICS, by K. Sato. Final rept. June 1959 [26]p. incl. illus. diagrs. (Rept. no. 1604) (AFOSR-TR-59-65) (AF 49(638)252) AD 264247

Unclassified

The primary objective of the program was to determine the conditions necessary to obtain a rapid chemical reaction in the immediate vicinity of a shock wave. The initial shock wave, generated in the gaseous oxidizer, was allowed to disperse the injected fuel droplets and to raise the temperature and pressure of the fuel-oxidizer mixture. It was then reflected from the end of the shock tube and allowed to pass through the dispersed fuel droplets and oxidizer. The course of the reflected shock wave was followed photographically to determine the degree of chemical reaction of the

fuel-oxidizer mixture. Results showed that the chemical reaction between the fuel and oxidizer was observed only after the passage of the reflected shock wave. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

THE ROLE OF BINDER IN COMPOSITE PROPELLANT COMBUSTION, by R. F. Chaiken and W. H. Andersen. July 1959 [24]p. incl. diagrs. tables, refs. (Rept. no. TN-30) (AFOSR-TN-59-540) (AF 49(638)-566) AD 216557; PB 149772

Unclassified

Presented at meeting of the Paint, Plastics, and Printing Ink Chem. Div. of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 13-18, 1959, p. 15-Q.

Abstract published in 136th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 15-Q.

Also published in Prog. in Astronaut. and Rocketry, v. 1: 227-249, 1960.

The interrelation of binder (fuel) and oxidizer during burning of conventional types of solid composite propellants is discussed in terms of the mechanism of the combustion process. A major feature of most contemporary theories of composite propellant combustion is that diffusion processes are involved in the chemical reactions between the gaseous pyrolysis products of the oxidizer and binder. However, the importance of these diffusion processes in affecting the propellant-burning characteristics depends upon the relative rates of reaction between the oxidizer-binder pyrolysis products and the oxidizer pyrolysis products alone. Utilizing the recently developed "Two-Temperature" and "Thermal Layer" theories of combustion, it is possible to delineate the various effects of these gaseous reactions on the propellant burning rate. These theories have been extended semi-quantitatively to include the effects of dilution, diffusion, and fast chemical reaction of the gasified binder. The combustion of ammonium nitrate and ammonium perchlorate propellants is discussed in terms of the described concepts, and compared with experimental data where possible. Evidence is presented which suggests that the "order-of-magnitude" burning rates of most ammonium-nitrate-based propellants should be determined largely by the chemical decomposition behavior of the oxidizer, with the binder decomposition playing a secondary role. It is not clear that the same situation holds for ammonium-perchlorate-based propellants. The physical influence of the binder on the combustion process is also discussed briefly. (Contractor's abstract)

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Aerojet-General Corp., Azusa, Calif.

THE COLLOID ROCKET: PROGRESS TOWARD A

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CHARGED-LIQUID-COLLOID PROPULSION SYSTEM, by R. D. Schultz and L. K. Branson. [1959] [31]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-1334) (AF 49(638)656) AD 241055 Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct. 7-8, 1959), Boston, v. 1: 53-72, 1959. (AFOSR-637)

Theoretical and experimental research is described leading toward a space propulsion system in which microscopic oil droplets are produced with a high positive charge and accelerated electrostatically to exhaust velocities of over 50,000 mph with a specific impulse of over 2200 sec. This type of rocket system may prove to be of considerable value for controlling the orbit of an earth satellite, for earth-moon missions, and possibly for deep-space exploration such as a Mars or Venus probe. (Contractor's abstract)

25

Aerojet-General Corp., Azusa, Calif.

INVESTIGATION OF A CHARGED-COLLOID PROPULSION SYSTEM (Abstract), by R. D. Schultz. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)656) Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Preliminary measurements have been made of the initial charge-to-mass-ratio of liquid colloidal droplets produced by electrical dispersion from sharp needle tips maintained at high positive potentials. The needle tip is continuously wetted with liquid. Liquids tested include octoil, didecyl adipate, and polyalkylene glycol derivative ("flexol" plasticizer B-400, Union Carbide Chemicals Co.). Initial charge-to-mass-ratio for colloidal droplets of each liquid was approx 5×10^8 esu/g. Apparatus has been designed and a system is being constructed in which charge-to-mass-ratio of colloidal droplets and the momentum beam of charged colloids can be measured in high vacuum. Pressures as low as 5×10^{-7} mm Hg have been obtained and accelerating voltages, as high as 200 kv.

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Aeronautical Research Inst. of Sweden, Stockholm.

A THEORETICAL INVESTIGATION OF SECOND-ORDER SUPERSONIC INTERFERENCE EFFECTS, by B. J. Beane and M. T. Landahl. Apr. 1959 [17]p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-59-962) (AF 61(052)75) AD 243957; PB 144305 Unclassified

An approximate solution, valid for high Mach numbers,

for the 2nd-order supersonic flow problem of 2 interfering flow fields is given. The approximate solution requires that the spanwise curvature of the body flow field is small. A further approximation is made which leads to a very simple formula for the interference pressure. This formula is found to give relatively small errors in the cases investigated. It is found that 2nd-order interference effects may be large at Mach numbers above 3. It is demonstrated that large gains in control surface efficiency may be obtained by placing the control surface in a region of high pressure from the body. (Contractor's abstract)

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Aeronutronic, Newport Beach, Calif.

ENHANCEMENT OF GAS PHASE CHEMICAL REACTION RATE DUE TO SIMULTANEOUS PERIODIC TEMPERATURE AND VOLUME PERTURBATIONS, by H. M. Wight. Apr. 1959, 27p. incl. diagrs. tables. (Technical note no. U-489) (AFOSR-TN-59-513) (AF 49(633)311) AD 264246 Unclassified

A research study was made of the effect of simultaneous temperature and volume variations on gas phase chemical systems having well established kinetics. The specific systems selected for study were: (1) the decomposition of HI; and (2) the direct synthesis of HBr. A theoretical analysis was made which predicts reaction rate enhancements should occur for systems subjected to periodic perturbations in volume and temperature. The enhancement arises essentially from the non-linear temperature dependence of the rate constants. For a chain reaction such as HBr synthesis, the predicted rate enhancement falls off mildly with an increase in the perturbation frequency. (Contractor's abstract)

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Aeronutronic [Newport Beach, Calif.].

ON STUDY OF METHODS OF PRODUCING HIGH-SPEED PARTICLES, by T. Bergstrahl, D. Krucoff and others. Final rept. Nov. 1959, 65p. incl. illus. diagrs. tables, refs. (Rept. no. U-698) (AFOSR-TR-59-181) (AF 49(638)366) AD 229718; PB 144731 Unclassified

Methods were investigated for accelerating, measuring the size and velocity, and effects of impacts, of small particles with diameters in the range of 1 to 1000 μ to velocities of 5 to 10 km/sec. The primary interest in meteoritic impact effect is on missiles, satellites, and space vehicles. The experimental efforts were limited to electromagnetic and light gas gun techniques since the particles involved in meteoritic impact have diameters greater than 1 micron. Two methods of electromagnetic acceleration were studied: (1) the single coil, repulsion solenoid, employing a thin disc as the sabot;

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and (2) a variant of the exploding wire technique. An adaptation of the single-chamber, directly heated, light gas was undertaken. (ASTIA abstract)

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Aeronutronic, Newport Beach, Calif.

MAGNETOHYDRODYNAMIC WAVES (Abstract), by T. A. Bergstrahl. [1959] 1p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)670)
Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Aeronutronic is undertaking an experimental study of magnetically driven shock waves in ionized media. It is intended to drive shocks through an already ionized medium of sufficient conductivity to insure that the magnetic flux remains with the plasma. The diffusion of the magnetic flux with respect to the plasma will be measured. The motion in these magnetohydrodynamic waves will be studied by means of voltage induced in wire loops and by optical methods. The program is intended to experimentally determine the equation of state of the shocked gas and the instabilities at the interface between the plasma and the propelling magnetic field. The program is just being started. The planned experiments are outlined.

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Aeronutronic Systems, Inc., Glendale, Calif.

PROJECT FARSIDE (Unclassified title), by R. G. Taylor (Thiokol Chemical Corp., Elkton, Md.). [1959] 1v. incl. illus. diagrs. tables. (Thiokol Chemical Corp. Elkton Div. rept. no. E 60-57) (AFOSR-TR-59-18) (AF 49(638)55) AD 314403L
Confidential

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Air Force Office of Scientific Research, Washington, D. C.

PERFORMANCE OF CLOSED-LOOP FLIP-FLOP CONTROL SYSTEM IN MISSILES AND ROCKETS, by M. Rogers and G. Shapiro. [Apr. 15, 1959] 1v. incl. diagrs. (AFOSR-TN-59-349) (In cooperation with Westinghouse Electric Corp., Baltimore, Md.) AD 213677; PB 143593
Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 841-853, Nov. 1960.

The basic concepts underlying the synthesis and analysis of closed-loop, flip-flop control systems of the electromechanical type are developed. Generalized design and analysis charts are presented to aid the engineer in

quickly gaining an understanding of the relative importance of various elements in the system to the system's performance and stability. The importance of considering not only control-system dynamics, but also the damping provided by the airframe in developing practical flip-flop control systems is forcefully demonstrated to the engineer and scientist. Analog computer data, obtained as part of the present study, are used to substantiate analytic approaches and to advance the understanding of such systems. (Contractor's abstract)

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Air Force Office of Scientific Research, Washington, D. C.

POSSIBLE EFFECTS OF CURRENT RESEARCH IN AUTOMATIC INFORMATION HANDLING ON TECHNICAL WRITING AND PUBLISHING, by H. Wooster. [1959] 18p. incl. refs. (AFOSR-TN-59-484) (Sponsored jointly by Air Force Cambridge Research Center, Air Force Office of Scientific Research, Council on Library Resources, Office of Naval Research, Rome Air Development Center, and National Science Foundation)
Unclassified

Presented at meeting of the Tech. Publishing Soc., San Diego, Calif., May 22, 1959.

The possible effects of current research and development in fields of mechanical translation, character reading, automatic abstracting, information storage, retrieval, and pattern recognition are reported. A brief explanation of each of these is given. Some of the problems of information distribution are discussed including the dissemination problem. The role of automatic information handling within the context of these problems is examined. It is concluded that there are many things in this field that machines can do as well as people; applications may save the efforts of people for things that machines cannot do.

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Air Force Office of Scientific Research, Washington, D. C.

VISTAS IN ASTRONAUTICS, VOLUME II. PROCEEDINGS OF THE SECOND ANNUAL AIR FORCE OFFICE OF SCIENTIFIC RESEARCH ASTRONAUTICS SYMPOSIUM, Denver Colo., Apr. 28-30, 1958, ed. by M. Alperin and H. F. Gregory. New York, Pergamon Press, 1959, 318p. incl. illus. diagrs. tables, refs. (Internat'l. Series of Monographs on Aeronaut. Sci. and Space Flight) (AFOSR-TR-59-94) (Sponsored jointly by Air Force Office of Scientific Research and Institute of Aeronautical Sciences)
Unclassified

At the 2nd Astronautics Symposium, papers were presented dealing with space environment and vacuum research, control and propulsion of vehicles outside the atmosphere, departure and space navigation and re-entry problems, and the earth's moon. It was noted that unmanned vehicles could achieve better scientific

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information in some instances, but that man would eventually venture out into space. Before that time, however, much more information must be acquired.

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Air Force Office of Scientific Research, Washington, D. C.

PROCEEDINGS OF A SYMPOSIUM ON ADVANCED PROPULSION SYSTEMS, Los Angeles, Calif., Dec. 11-13, 1959, ed. by M. Alperin and G. P. Sutton. New York, Pergamon Press, 1959, 237p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-166) (Sponsored jointly by Air Force Office of Scientific Research and North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif.)

Unclassified

This symposium was aimed at bringing together American scientists and engineers engaged in the establishment of the fundamental principles of propulsion for space vehicles. It was realized that the conventional rocket propulsion based solely on chemical propellants had limitations that were fast being approached and that a new type propulsion system was needed. The symposium included reports on all phases of rocket propulsion plus a test firing of the power plant for the Atlas missile. Its publication was delayed because of the classified status of the reports, but a slackening of security and requests for publication led to the volume.

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Alabama U., University.

CONDUCTANCE OF THE HEXAFLUORO COMPLEXES OF THE FOURTH GROUP, by E. L. Grove and R. Schmitt. July 25, 1959, 54p. incl. diagrs. tables, refs. (AFOSR-TN-59-616) (AF 18(600)1567) AD 230706; PB 145639

Unclassified

An investigation was made of the variation of equivalent conductance with concentration for 18 alkali-hexafluoro complex solutions. The electrolytes included the K, Rb, and Cs hexafluoro complexes formed with Si, Ge, Sn, Ti, Zr, and Hf. Plots of the equivalent conductance vs the square root of the concentration of the compounds yielded typically weak electrolyte curves. Cryoscopic determinations carried out with 0.03, 0.02, and 0.01 molar solutions indicated that 3 ions are formed for each molecule of salt. The pH of all solutions was almost constant for concentrations ranging from 10^{-1} to 10^{-4} equivalents per liter. It was suggested that these properties are caused by the following 3 reactions which occur when a hexafluoro complex is dissolved: (1) the salt ionizes by the mechanisms $K_2MF_6 \rightarrow 2K^+ + MF_6^{--}$, where M is a Group IV element; (2) the hydroxyl ions compete with the fluoride ions as substituents in the coordination sphere of the hexafluoro complex ion as shown by $MF_6^{--} + 2nH_2O \rightarrow MF_{6-n}(OH)_n^{--} + nF^- + nH_3O^+$, where n has no exact

value but is usually zero; and (3) the equilibrium $HF \rightarrow F^- + H^+$. The constancy of the pH is thought to be explained by the presence of the buffer, alkali fluoride, and hydrofluoric acid. A sharp increase in equivalent conductance at low concentrations was attributed to the contribution of the fast moving hydronium ion. (ASTIA abstract)

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Alabama U., University.

A STUDY OF THE GALLIC ACID COMPLEXES OF NIOBIUM, TANTALUM, TITANIUM, AND IRON, by E. L. Grove, L. Maddox, and W. S. Jeffers. July 26, 1960, 11p. incl. diagrs. table. (AFOSR-TN-59-1183) (AF 18(600)1567) AD 248631

Unclassified

Presented at Chem. Sect. of the Thirty-fifth annual meeting of the Alabama Acad. Sci., Howard College, Birmingham, Ala., Mar. 31-Apr. 2, 1958.

Abstract published in Jour. Alabama Acad. Sci., v. 30: 13, Oct. 1958.

The use of gallic acid as a spectrophotometric procedure for both tantalum, and niobium was investigated. The optical properties of several other metal chelates were also explored. The pH effects on the absorption of niobium, tantalum, and vanadium-gallate chelates is summarized. It is pointed out that it should be possible to develop a colorimetric procedure for tantalum and rhenium without prior separation.

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Alfred U. New York State U. Coll. of Ceramics, N. Y.

DIFFUSION IN ALKALI HALIDES AT LOW TEMPERATURES, by T. J. Gray and P. G. Harrison. [1959] [11]p. incl. illus. diagrs. (AF 18(600)1448)

Unclassified

Published in Faraday Soc. Discussions, No. 28: 81-85, 1959.

The results of diffusion studies made on alkali halide crystals grown from solution are presented and contrasted with those grown from the melt. Confirmation is made that the predominant feature is the initial distribution of impurities achieved during growth from solution. However, heating the crystals to a temperature corresponding to the "knee" in the classic diffusion relationship reveals that the relationship is contiguous with the classical curve for high temperatures. From this and other evidence, it seems certain that the low-temperature process is definitely associated with the aggregation of impurities and vacancies at dislocations. It is also pointed out that the solution-grown crystals contain 2 orders of magnitude less hydroxyl ion than do typical melt-grown crystals. In addition, no dielectric relaxation phenomena have been observed in any

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solution-grown crystals until after heating to above the "knee" temperature; and after heat treatment has occasioned aggregation, the rate of F-center formation increases by 30 to 50%. It is believed that this evidence precludes the acceptance of any oversimplified theoretical treatment which ignores the complexity introduced by aggregation at dislocations.

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Alfred U. New York State U. Coll. of Ceramics, N. Y.

THE KINETICS OF F-CENTER FORMATION IN ALKALI HALIDES AS A FUNCTION OF PRECIPITATION AT DISLOCATIONS (Abstract), by T. J. Gray and P. G. Harrison. [1959] [3]p. (AF 13(600)1448)

Unclassified

Published in Proc. 1959 Internat'l. Symposium on Color Centers, Oregon State Coll., Corvallis (Sept. 8-11, 1959) [Salem] Oregon State Board of Higher Education, 1959, p. 25-26.

A report on a technique by which the phenomena of F-center development can be studied is presented. An apparatus was designed by which specimens are automatically irradiated for constant periods of time and then moved by linear actuator to a position where they are illuminated at extremely low light intensity from a monochromator and the optical adsorption measured automatically. The time of exposure is substantially less than 1 sec after which the crystal is returned to the x-ray beam. By suitable coupling to a recorder, an intermittent trace is obtained by giving direct display of the development of the adsorption due to F-centers against time for the selected temperature. From these curves, the kinetic relationships for the process can be developed and comparison for several temperatures enables the activation energy for the process to be determined directly.

39

Allied Research Associates, Inc., Boston, Mass.

STAGNATION POINT MELTING AND ABLATION, by T. R. Goodman and C. Chin. Mar. 30, 1959, 18p. incl. diags. (AFOSR-TN-59-390) (AF 49(638)347) AD 213894; PB 140523

Unclassified

An investigation of melting and aerodynamic ablation in the vicinity of the stagnation point of blunt bodies is presented. Numerical results for an axially symmetric aluminum body are included. The results show that the quasi-steady solution is in excellent agreement with the complete solution except at the start of the ablation process. A numerical comparison has been made between ablation at the stagnation point of a blunt body and ablation of a flat plate (from an analysis given in an earlier report) both in the same environment and having comparable dimensions. This shows that unsteady effects may persist an order of magnitude

longer for a complete body than they do near the stagnation point. Consequently, it may be necessary to account for these unsteady effects in re-entry vehicles even though an analysis based on behavior near the stagnation point indicates that they can be ignored. (Contractor's abstract)

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American Mathematical Soc., Providence, R. I.

MATHEMATICS ADVISORY AND EVALUATION SERVICES. Jan. 1959-Dec. 1959. (AF 49(638)204)

Unclassified

This contract provides for an evaluation service to the Mathematics and Applied Mathematics Divisions of the Mathematical Sciences Directorate. Upon request, distinguished mathematicians review and evaluate proposed new directions for mathematical research, new mathematical ideas, and the importance of contemporary mathematical results. The contract also provides for an AFOSR Mathematics Advisory Committee which weighs the general direction of mathematical research, in particular of research supported by the Mathematics and Applied Mathematics Divisions of the Mathematical Sciences Directorate.

41

American Mathematical Soc., Providence, R. I.

CURRENT MATHEMATICAL DEVELOPMENTS. Feb. 1958-Dec. 1959. (AF 49(638)291)

Unclassified

This contract provides for the preparation of a series of reports or books on selected topics in modern mathematics. These reports are prepared by experts in their prospective fields and are written in an expository style. The exposition is pitched at a level accessible to 1st or 2nd year graduate students of science and engineering, and the authors are encouraged to emphasize point of contact with other areas of science. Thus the books should be both interesting and intelligible to professionals in other areas of science and engineering. It is planned that each book be systematic and as far as possible self-contained so that a qualified reader could hope not only to begin the reading of such a book, but to work through it and in doing so to acquaint himself with the principal methods and results in the area covered by the book. One of the main features of these books is the emphasis placed on recent developments and their relationship to other areas of mathematics and science.

42

American Soc. of Mechanical Engineers, New York.

APPLIED MECHANICS REVIEWS, ed. by M. Goland. 1959. (M1PR-680-59-11 and Nonr-275700)

Unclassified

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This project is for the production of a monthly journal, reviewing current literature in the field of theoretical and applied mechanics.

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Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

THE PHYSICAL CHEMISTRY OF WATER SOLUTIONS AT HIGH TEMPERATURES AND PRESSURES. Final rept. July 1, 1955-June 30, 1959, 1v. incl. diagrs. tables, refs. (AFOSR-TR-59-74) (AF 18(600)1490) AD 220103 Unclassified

The work of this project has been divided into 2 main sections: (1) the investigation of chemical reactions that take place in water solutions at high temperatures and pressures, and (2) the measurement of the conductivity of salt solutions under supercritical conditions. The chemical reactions investigated include the silicon dioxide water system, the germanium dioxide water system, the aluminum dioxide water system, and the effect of fluoride ion on the equilibrium involved in the silicon dioxide and aluminum oxide system. The occurrence of a conductivity difference between the top and bottom of a platinum lined spark plug autoclave containing NaCl and KCl has been confirmed and measured. The conductivity varies with concentration and solution density in the same manner as that reported in the literature for homogeneous systems. The following reports and publications are appended to this report: item nos. ANT.03:001, 009-011, Vol. II, and item nos. 44-49, this volume.

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Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

TETRASODIUM ENNEAGERMANATE, $\text{Na}_4\text{Ge}_9\text{O}_{20}$, TETRAGONAL FORM, by J. F. White, E. R. Shaw and others. [1959] [2]p. incl. illus. table. (In cooperation with California U., Berkeley, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 36-039-sc-73211) Unclassified

Published in Anal. Chem., v. 31: 315-316, Feb. 1959.

Euhedral crystals of previously undescribed $\text{Na}_4\text{Ge}_9\text{O}_{20}$ were prepared hydrothermally by the reaction of germanium dioxide-sodium hydroxide mixtures and water at 200°C and 12 atm. Crystallographic data are given.

45

Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

THE EFFECT OF pH ON THE FORMATION OF

DIASPORE AND CORUNDUM, by R. G. Yalman, E. R. Shaw, and J. F. Corwin. [1959] [17]p. incl. diagr. tables. (Bound with its AFOSR-TR-59-74; AD 220103) [AF 18(600)1490] Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 36-M - 37-M. (Title varies)

The conversion of gibbsite to boehmite and diaspora was investigated in 30-day runs at 350° and 5000 psi in aluminum sulfate and sodium aluminate solutions. No diaspora was observed in the absence of a seed nor in acid solutions. In alkaline solutions the rate of diaspora formation increased with increasing sodium aluminate concentration. A similar study at 400° and 6200 psi showed that the conversion of gibbsite to boehmite and corundum was also pH-dependent, and that the conversion of gibbsite to corundum *in situ* occurs more readily in the presence of a sapphire seed. No corundum was formed in acid solutions. The transfer of alumina from gibbsite to a sapphire seed occurs in potassium fluoride solutions, the rate of transfer increasing with increasing potassium fluoride concentrations. At the same time potassium cryolite, K_3AlF_6 , is formed. In concentrated solutions crystals of potassium cryolite will grow at the expense of the sapphire seed. The effect of fluoride upon the hydrothermal growth of quartz crystals in the presence of aluminum and the equilibrium between tetraordinated and hexacoordinated aluminate ions is discussed.

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Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS IN THE $\text{Na}_2\text{O-GeO}_2\text{-H}_2\text{O}$ SYSTEM. II. INFRARED STUDIES OF GERMANIUM DIOXIDE, by E. R. Shaw, J. F. Corwin, and H. V. Knorr. [1959] [9]p. incl. diagr. table, refs. (Bound with its AFOSR-TR-59-74; AD 220103) (AF 18(600)-1490) Unclassified

Also published in Jour. Phys. Chem., v. 64: 174-175, Jan. 1960.

The infrared patterns of the 3 forms of germanium dioxide obtained by various methods have been prepared and the principle bands in the 2-15 μ region are reported at: amorphous - 11.25 μ ; hexagonal - 10.43 μ , 11.45 μ ; tetragonal - 12.90 μ , 13.90 μ . It is shown that the appearance of the broad strong band of the "hydrolysed" form at 11.35 μ is a result of incomplete inversion and is thus due to the presence of minute centers of the amorphous form. (Contractor's abstract)

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Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

HYDROTHERMAL REACTIONS IN THE $\text{Na}_2\text{O-GeO}_2\text{-H}_2\text{O}$ SYSTEM. III. INFRARED STUDIES OF THE ALKALI GERMANATES, by E. R. Shaw, J. F. Corwin, and H. V. Knorr. [1959] [16]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-74; AD 220103) (AF 18-600)1490) Unclassified

Infrared spectroscopic studies were made of the alkali germanates, including lithium, sodium, potassium, rubidium, and cesium. The method of preparation of the crystals was the same as that used previously (see item no. ANT.03:009, Vol. II), but with varying reaction temperatures. The preparation temperatures and observed indices of refraction are given. It was found that considerable variation in spectra results from change in crystalline form, while slight variations, found with change in crystalline habit, disappear with proper grinding. As the crystals which separated as single phases were sometimes homogeneous in size and habit it was also possible to show the effects on the infrared patterns of using whole crystals of near the $5\ \mu$ particle size reported as the maximum in the literature for inorganic infrared spectroscopy.

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[Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio]

STUDY OF THE EFFECT OF pH AND FLUORIDE ION ON HYDROTHERMAL REACTIONS OF SILICA AND ALUMINA, by R. [G.] Yalman. [1959] 21p. incl. tables, refs. (Bound with its AFOSR-TR-59-74; AD 220103; [AF 18(600)1490]) Unclassified

A study of the hydrothermal reactions of silica and alumina in the presence of fluorides is presented by reviewing the 3 major parts of this research. The 1st (ANT.03:011, Vol. II) dealing with the effect of fluoride on the hydrothermal formation of quartz, shows that the "mineralizing" action of fluoride ion is due to the hydrolysis of the fluoride ion, and that the concentration of the hydroxide ion formed determines the kind of crystalline silicon dioxide produced. The 2nd, concerned with the effect of fluoride on the hydrothermal formation of corundum, shows that potassium cryolite, K_3AlF_6 ,

forms increasingly with the length of run and increasing potassium fluoride concentration. A correlation was attempted for the aluminum system to ascertain the relationship between corundum formation rate and basicity of the solution. The results show that corundum is formed only in very weakly acid solutions and that growth occurs in alkaline solutions. Similar results were obtained for the formation of diaspore. The 3rd part, formation constants of fluoro complexes, arrives at its results by utilizing the fact that the thiocyanate complexes of ferric ion have a very large molar extinction coefficient at 460 m μ , while the fluoro com-

plexes of iron do not absorb light in the visible or near ultra-violet region. The results are presented in table form with their respective molar coefficients and are of the order of 138 at 26.1°C , varying slightly with temperature. Formation constants of the iron complexes formed with aluminum, boron, silicon and molybdenum are also given.

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Antioch Coll. Dept. of Chemistry, Yellow Springs, Ohio.

THE CONDUCTIVITY OF DILUTE SODIUM CHLORIDE SOLUTIONS UNDER SUPERCRITICAL CONDITIONS, by J. F. Corwin and R. G. Bayless. [1959] [26]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-74; AD 220103) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1490 and Signal Corps under DA 36-039-sc-64605) Unclassified

Also published in Jour. Phys. Chem., v. 64: 641-646, May 1960.

The conductivity of aqueous sodium chloride solutions above the critical temperature for the solution differs by a considerable amount when the electrode system is located at the top of the container from that when the electrodes are at the bottom. The difference is a function of the degree of filling (steam density) and is minimized by increasing the amount of solution in the container. A concentration gradient in the solution is proposed to explain the difference and comparisons are made with existing data which were made under conditions where homogeneity was artificially maintained or ignored by equipment design. (Contractor's abstract)

50

Arkansas U. [Dept. of Physics] Fayetteville.

ISOTOPE SHIFTS IN THE RuI SPECTRUM (Abstract), by R. H. Hughes. [1959] [1]p. [AF 18(603)26] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 262, Apr. 30, 1959.

The hollow cathode spectra from isotopically enriched samples of ruthenium ($Z = 44$) have been studied with the use of a Fabry-Perot interferometer. The following shifts in mK were measured for the $\lambda 4449\text{-A}$ line. The minus sign indicates a shift in the field effect direction.

98-96	100-98	102-100	104-102
~-36.2	~-15.2	-22.7	-25.1

99-93	101-100	104-96
~+1.6	-4.3	-99.5

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The uncertainty in the shifts relative to Ru-98 is brought about only by the isotopic impurity of the 98 sample. The estimated limit error on the other measurements is about ± 1.8 mK. Although the minimum in the shifts between neutron numbers 55-54 might possibly be exaggerated a small amount (say 4 mK), there is little doubt that it exists. A similar minimum has been found in molybdenum at these neutron numbers. The comparison of the 99-98 shift with a strong even-odd staggering effect found in molybdenum which produces a change in the sign of the shifts between neutron numbers 55-54 might support a contention that the Ru-98 position has not been chosen to exaggerate the 100-98 minimum. The presence of this minimum was predicted from nuclear deformation data as measured by Coulomb excitation experiments.

Armour Research Foundation, Chicago, Ill. see Illinois Inst. of Tech. Armour Research Foundation, Chicago.

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Athens U. Dept. of Physics (Greece).

THE CHARACTERISTIC TEMPERATURE OF SILVER FROM X-RAY REFLECTIONS, by J. Boskovits, M. Roilos and others. [1959] [3]p. incl. diagr. tables. (AFOSR-TN-59-294) (AF 61(514)1248) AD 213034
Unclassified

Also published in Acta Cryst., v. 11: 845-847, Dec. 1958.

The present paper describes experiments carried out in order to determine the characteristic temperature θ of silver. The method consists in scattering a pencil of x-rays on a silver wire and measuring the intensity of the diffracted rays at different temperatures. The changes of intensity then give the value of θ according to the usual Debye theory. In the light of modern theory of solids, the characteristic temperature is not a constant but can show a considerable change with temperature. The integrated intensity of diffraction lines (111) and (422) was measured at 6 different temperatures between 81°K and 774°K. The scattering sample was heated above room temperature by blowing a vertical stream of hot air onto the wire. The cooling below room temperature was obtained with a suitable vacuum cryostat. The temperature of each measurement was determined from the angular shift of diffraction line (422). By applying the formula of the usual Debye theory to each neighboring pair of temperatures, a value of θ was obtained. Each value of θ corresponds to a temperature which lies at the middle of the temperature interval. The following results were obtained:

Temperature °K	138	243	405	592	726
Characteristic temperature	203	233	200	178	121

The error in each value of θ was of the order of 3 to

20°. The results give a fall of θ with increasing temperature. The results at temperature above room temperature do not coincide with the results found by Andriesen. His measurement gave a constant value of $\theta = 218$ up to temperature of 670°K. A discussion of the possible reasons for such a disagreement does not lead to any explanation. Neither extinction nor oxidation would give such low values as found in the present measurements. (Contractor's abstract)

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Atlantic Research Corp., Alexandria, Va.

THE MECHANISM OF DEFLAGRATION OF PURE AMMONIUM PERCHLORATE, by R. Friedman, J. B. Levy, and K. E. Rumbel. Feb. 5, 1959 [34]p. incl. diagrs. tables, refs. (AFOSR-TN-59-173) (AF 18(600)-1502) AD 211313; PB 139991
Unclassified

Results of new deflagration experiments with ammonium perchlorate, both pure and crystallized are presented. These include studies of rates of deflagration, pressure limits of deflagration, surface temperature, and effects of incident radiation on deflagration. These and previous results are interpreted in terms of a tentative qualitative model of the deflagration process.

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Atlantic Research Corp., Alexandria, Va.

RESEARCH ON SOLID-PROPELLANT COMBUSTION, by R. Friedman, J. B. Levy, and K. E. Rumbel. Final technical rept. July 1955-Oct. 1959. Nov. 30, 1959, 13p. incl. diagrs. tables, refs. (AFOSR-TR-59-192) (AF 18(600)1502) AD 230724; PB 145634
Unclassified

The results and progress of this program have been described in 3 technical notes (see item nos. ATL01:001, 002, Vol. II, and item no. 52, this volume). Two other lines of investigation which have not been previously reported because of incomplete results, are described. The Chemical Nature of the Products of Deflagration of Ammonium Perchlorate: Measurements were made on pressed strands of ammonium perchlorate at pressures ranging from atmospheric to 2000 psi, both in the presence and absence of copper chromite catalyst. At high pressures and atm pressure the gaseous products formed were nitrogen, nitrous oxide and oxygen. The nitrogen in the products was present as molecular nitrogen, nitrous oxide, and nitrate ion. The effect of the catalyst was to bring about a very sharp decrease in nitrous oxide yield. Both the effect of strand cross-sectional area and the effect of the catalyst suggest that nitric oxide is the primary product and that it can react further to give nitrous oxide or nitrogen. The reaction of nitric oxide appeared to be favored by higher pressures; the nitrous oxide yield was independent of pressure up to 1000 psi. Studies of the Kinetics and

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Mechanism of the Thermal Decomposition of Anhydrous Perchloric Acid: Preliminary experiments were carried out on measured amounts of anhydrous perchloric acid, which were sealed in ampules, heated for various lengths of time in a constant-temperature bath, and the contents then analyzed. The reaction products were chlorine, water and oxygen. The results indicated that the reaction is at least partly heterogeneous below 400°C and that the half-life of anhydrous perchloric acid vapor at 400°C is of the order of 1 min.

54

Atlantic Research Corp., Alexandria, Va.

HIGH PRESSURE PLASMA PRODUCTION TECHNIQUE (Abstract), by R. Friedman and L. W. Fagg. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) [AF 49-(638)651] Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This program was initiated to study the feasibility of a novel and potentially convenient means for producing a concentrated high-pressure plasma and to explore the properties of such a plasma. The basic idea is that a powdered oxidizer such as cesium perchlorate or cesium nitrate might be mixed with a metal having a high heat of combustion (aluminum, beryllium, zirconium) and pressed together to form a brittle stick, or strand, which would burn like a propellant when suitably ignited, particularly at high ambient pressure. The combustion products would be sufficiently hot (about 4000°K) so that very high concentrations of Cs⁺ and free electrons will be present, thus providing a convenient high-pressure plasma source for experimental purposes. Cesium perchlorate has been synthesized, and it has been found that a stoichiometric mixture with aluminum can be formed into strong strands with less than 1% voids by pressing at 100,000 psi, and these strands will burn smoothly under nitrogen pressures in the range 400-2000 psi, and presumably higher pressures, with a burning rate of the order of 5 cm/sec. Thermodynamic calculations for this and other systems are being programmed, and experiments for measuring electron concentrations from the Q-factor of a high-frequency resonant circuit whose coil surrounds the plasma are being considered.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

AN ELECTROMAGNETIC ROCKET SYSTEM OF HIGH SPECIFIC THRUST, by R. J. Rosa. Apr. 1958, 10p. incl. diags. (Research rept. no. 103) (AFOSR-461) (AF 49(638)61) AD 256792 Unclassified

A nuclear-electric propulsion system is described which avoids the necessity for a low temperature heat sink. The system is an open thermodynamic cycle which in effect re-uses the working fluid several times without recirculating it. Although a very large specific impulse cannot be produced in this manner it does seem possible to get a substantial improvement in the impulse obtainable for a given nuclear pile temperature. In addition, the elimination of the heat sink increases the possibility of making nuclear-electric systems having a high thrust to weight ratio and an ability to function within the atmosphere. (Contractor's abstract)

56

Avco Corp. [Avco-Everett Research Lab.] Everett, Mass.

TABLES OF RADIATION FROM HIGH TEMPERATURE AIR, by B. Kivel and K. Bailey. Dec. 1957, 29p. incl. diags. tables, refs. (Research rept. no. 21) (AFOSR-TN-59-289) (Sponsored jointly by Air Force Ballistic Missile Div. under AF 04(645)18) and Air Force Office of Scientific Research under AF 49(638)61) AD 212921 Unclassified

Tables of radiative emissivity of hot air in the range of temperature from 1000°K to 18,000°K and density from 10 to 10⁻⁶ of a normal atmosphere are presented. The radiative intensities are presented in graphical form.

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Avco Corp. [Avco-Everett Research Lab.] Everett, Mass.

SUPERSONIC TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW, by F. Fishman, J. W. Lothrop and others. Feb. 1959, 49p. incl. illus. diags. (Research rept. no. 39) (AFOSR-TN-59-290) (Sponsored jointly by Air Force Ballistic Missile Div. under AF 04(647)278 and Air Force Office of Scientific Research under AF 49-(638)61) AD 212922; AD 211723; PB 147199 Unclassified

Also published in Proc. Third Symposium on Magneto-hydrodynamics, Lockheed Research Lab., Palo Alto, Calif. (Nov. 21-22, 1958), Stanford, Stanford U. Press, 1959, p. 90-119.

A perturbation theory was applied to the supersonic flow of a conducting fluid through the magnetic field of a circular solenoid. Calibrated view camera pictures of the light emitted by the gas are in agreement with predictions based on the perturbation theory. Experimental verification of the prediction that lift forces can be achieved with geometrically symmetric bodies by utilizing the Hall effect has been given. Estimates of the experimental lift forces indicate a lift coefficient of about 0.4 and a lift-drag ratio of approximately unity. For very strong magnetic fields the experimental flow pattern becomes similar to the flow pattern around a solid

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cylinder. The possibility of using magnetohydrodynamic forces in flight depends upon the fact that the gas behind a normal shock at hypersonic velocities is heated sufficiently to become a good conductor. Such a normal shock could be supported by magnetic field. In order to achieve MHD forces in flight the interaction parameter based on conditions behind the shock wave must be large enough to support the shock. This occurs for drag coefficients near unity. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PLASMA PROPULSION DEVICES FOR SPACE FLIGHT, by M. Camac, A. Kantrowitz, and H. E. Petschek. Feb. 1959, 40p. incl. diagrs. table. (Research rept. no. 45) (AFOSR-TN-59-385) (AF 49(638)61) AD 213885
Unclassified

Also published in I.R.E. Trans. on Military Electronics, v. MIL-3: 34-41, Apr. 1959.

An analysis was made of the more immediate space missions to specify whether a large increase in payload can be achieved when electrical propulsion is used instead of chemical propulsion. For military missions such as the stationary communication satellite and moon missions, the desirable specific impulse range is from 1500 to 5000 sec. For these missions electrical propulsion can effect a reduction in initial ground level launch weight requirements by a factor of 2 or 3. Conversely, for the same ground rockets, a 2 or 3 times larger payload can be delivered to the final orbit when electrical propulsion is used. Electrical propulsion with neutral plasma devices operate well in this specific impulse range (1500 to 5000 sec) as well as at higher specific impulses. Three different chambers are described as examples of devices using neutral plasmas. Some of the factors which limit the range of efficient operation of such devices are discussed. In the section entitled "Supplementary Information on Lunar and 24-Hour Orbit Missions," the following topics are discussed: (1) propulsion requirements for placing a 24-hr communication satellite in orbit starting from a 150 mi altitude orbit, (2) thrust requirements for rotation of the orbit plane and the application to 24-hr orbit transfer mission, (3) thrust requirements to maintain a 24-hr communication satellite at a given position for 10 yr., and (4) propulsion requirements for round trip moon missions from a 150 mi altitude orbit above the earth to a low altitude circular orbit above the moon.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

A FURTHER NOTE ON HYPERSONIC STAGNATION POINT FLOW WITH A MAGNETIC FIELD, by N. H. Kemp. Apr. 1959, 15p. incl. diagrs. (Research rept.

no. 53) (AFOSR-TN-59-445) (AF 49(638)61) AD 214807; PB 142152
Unclassified

Several notations are made related to a former paper (AVC.01:001, Vol. II) by the author. Included are corrections of numerical solutions of the inviscid vorticity equation, solutions of viscous boundary layer problems for an axisymmetric stagnation point with magnetic field, and some implications of these solutions for reducing the stagnation point heat transfer rate and shear stress.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

HIGH SPEED SHOCK WAVES IN A MAGNETIC ANNULAR SHOCK TUBE, by R. M. Patrick. July 1959, 36p. incl. illus. diagrs. refs. (Research rept. no. 59) (AFOSR-TN-59-845) (AF 49(638)61) AD 225292; PB 143155
Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct. 7-8, 1959), Boston, v. 1: 151-168, 1959. (AFOSR-637)

Also published in Phys. Fluids, v. 2: 589-598, Nov.-Dec. 1959.

A magnetic annular shock tube was used to produce magnetically driven shock waves with very high velocities. Experiments were carried out with this device with 2 magnetic field configurations ahead of the shock front. The first configuration had a magnetic field ahead of the shock front in the direction of motion of the shock. In the second configuration the magnetic field ahead of the shock had its principal component in the plane of the shock front and a small component in the direction of motion of the shock. The continuum radiation emitted by the shock-heated plasma was measured with photomultipliers. The use of probes to measure the change in the local magnetic field in the shock front was investigated. With the second configuration shock velocities in excess of 4×10^7 cm/sec were measured in hydrogen. For these high speed shock waves, a shock thickness was obtained from measured rise times of the emitted visible radiation. These shock thicknesses are thinner than the mean free path in the shock-heated plasma, an observation which agrees with a theoretical prediction. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

THEORY OF THE FLOW IN THE MAGNETIC ANNULAR SHOCK TUBE, by N. H. Kemp and H. E. Petschek. July 1959, 35p. incl. diagrs. (Research rept. no. 60) (AFOSR-TN-59-846) (AF 49(638)61) AD 225774; PB 143521
Unclassified

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Also published in Phys. Fluids, v. 2: 599-608, Nov.-Dec. 1959.

A theoretical description is given of the properties of the gas flow in the magnetic annular shock tube. This shock tube uses a magnetic field to drive a shock wave through an annular region, producing a very high temperature plasma. It is shown that this particular configuration allows a fairly precise calculation of the flow parameters. Numerical calculations of the significant flow properties for a complete range of the initial field strength and orientation have been made and are presented graphically.

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Avco Corp. [Avco-Everett Research Lab.] Everett, Mass.

FLIGHT MAGNETOHYDRODYNAMICS, by A. R. Kantrowitz. Mar. 1959, 18p. incl. illus. diags. (Research rept. no. 51) (AFOSR-TN-59-882) (Sponsored jointly by Air Force Ballistic Missile Div. under AF 04(067)278 and Air Force Office of Scientific Research under AF 49(638)61) AD 230023; PB 144785
Unclassified

A brief discussion is given of the possible flight applications of magnetohydrodynamics and the conditions under which they might be practical. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

NUMERICAL CALCULATION OF ABSOLUTE BREMSSTRAHLUNG INTENSITY FOR A FULLY IONIZED FULLY DISSOCIATED HYDROGENIC GAS, by G. S. Janes and H. E. Koritz. Sept. 1959, 13p. incl. diags. table. (Research rept. no. 70) (AFOSR-TN-59-1076) (AF 49(638)61) AD 228740; PB 144345
Unclassified

Also published in Jour. Appl. Phys., v. 31: 525-528, Mar. 1960.

Using the approximate relationships of Kirkpatrick and Weidmann (Phys. Rev., v. 67: 321, 1945) for bremsstrahlung intensities numerical calculations were made on the IBM 650 for a fully ionized, fully dissociated hydrogenic gas. The intensities are given in terms of a quantity having the units ergs/sec/unit frequency interval/steradian/cc as a function of $h\nu$, (from 0.5 to 4.0 electron v) and kT (from 4 to 200 electron v). A calibration method was devised for measurement of absolute bremsstrahlung intensities, which continually compensates for the errors present in most calibration procedures. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

COLLISION FREE MAGNETOHYDRODYNAMIC SHOCK WAVE, by A. Kantrowitz, R. M. Patrick, and H. E. Petschek. Aug. 1959, 12p. incl. diags. (Research rept. no. 63) (AFOSR-TN-59-1190) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)61 and Office of Naval Research under Nonr-252400) AD 228384; PB 148187
Unclassified

Also published in Fourth Internat'l. Conf. on Ionization Phenomena in Gases, Uppsala, Sweden (Aug. 17-21, 1959), Amsterdam, North-Holland Publishing Co., 1960, p. 1086-1091.

It is assumed that the dissipation in a collision free shock produces a random distribution of magnetohydrodynamic waves. These waves are then treated as the fundamental particles of the plasma. A rough kinetic theory is developed which estimates the heat conduction coefficient due to the waves. Using this heat conduction coefficient, the shock thickness is estimated to be about 4 times the characteristic ion Larmor radius. This prediction is in rough agreement with experimental results obtained in a MAST device. (Contractor's abstract)

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

ON THE FLOW OF A VISCOUS ELECTRICALLY CONDUCTING FLUID, by H. P. Greenspan. Oct. 1959, 32p. incl. diags. (Research rept. no. 73) (AFOSR-TN-59-1221) (AF 49(638)61) AD 231877; PB 145772
Unclassified

Also published in Quart. Appl. Math., v. 18: 408-411, 1960/1961.

The magnetohydrodynamic flow of a viscous incompressible fluid of constant properties past a flat plate is considered. The applied magnetic field is parallel to the free stream direction and the plate is at zero angle of attack. A number of explicit solutions of the linearized theory are presented for the flow past a semi-infinite plate which is either sucking or injecting a conducting fluid into the main stream. Unlike the case of super-Alfvén flow (where the free stream velocity is greater than the Alfvén wave speed) no solution exists in the problem of sub-Alfvén flow past a semi-infinite flat plate which is either impermeable or injecting fluid. Special solutions do exist for certain values of the suction velocity. The sub-Alfvén flow past a long finite impermeable plate is studied in some detail and the magnitude of the viscous wake is compared to the similar type upstream disturbance produced by the forward propagation of Alfvén waves. In the case of infinite conductivity, it is found that the upstream disturbance is approximately 1 plate length long measured

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from the leading edge. The inadequacies and failures of the linearized theory of the super-Alfvén are discussed. (Contractor's abstract)

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[Avco Corp.] Avco-Everett Research Lab., Everett, Mass.

PRODUCTION OF VERY HIGH SPEED SHOCK WAVES (Abstract), by R. M. Patrick. [1959] [1]p. [AF 49-(638)61] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 283, Apr. 30, 1959.

A magnetically driven coaxial shock tube has been used to produce shock waves with very high velocities. In this device there is a magnetic field ahead of the shock front with its principal component in the plane of the shock front. The continuum radiation emitted by the shock-heated gas has been measured with photomultipliers. The use of probes to measure the change in the local magnetic field at the shock front has been investigated. Time integrated spectra have been taken of the light emitted from the shock tube. Shock velocities in excess of 3×10^7 cm/sec have been measured in hydrogen. For these high-speed shock waves, the shock thickness has been obtained from the measured rise times of the emitted visible radiation. These shock thicknesses are thinner than a mean free path for the conditions in the shock-heated gas, which agrees with a theoretical prediction.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

BASIC STUDIES IN MAGNETOHYDRODYNAMICS (Abstract). [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)61) Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

A shock wave propagating in a plasma where the cyclotron radius is much smaller than the mean free path provides a good opportunity to study the dissipative mechanisms associated with magnetohydrodynamic turbulence. Experiments have been performed using an electromagnetically driven shock wave which propagates in the annulus between 2 coaxial cylinders with an azimuthal magnetic field in the shock plane. The shock velocity and plasma density have been obtained by measuring the bremsstrahlung intensity. Shock velocities have been produced up to 4.5×10^7 cm/sec. The kinetic

energy corresponds to a temperature behind the shock of 1.2×10^6 °K, density 5×10^{15} ions/cc, mean free path 20 cm, and an ion cyclotron radius of .2 cm. Shock thickness obtained by measuring the time required for the continuum radiation to reach a steady value behind the shock was 2 cm. Shocks thinner than a mean free path could not be produced without a magnetic field in the plane of the shock. The observation of "thin" shocks confirms previous theoretical predictions and provides a powerful tool for the study of dissipative mechanisms in collision free plasmas.

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PROCEEDINGS OF THE SECOND SYMPOSIUM ON ADVANCED PROPULSION CONCEPTS (Unclassified title). VOL. I (Unclassified), VOL. II (Confidential), VOL. III (Secret-Restricted Data), Boston, Mass., Oct. 7-8, 1959, Washington, Government Printing Office, 1960, 3v. incl. illus. diagrs. tables, refs. (AFOSR-637) [AF 49(638)61] AD 255830

The Second Symposium on Advanced Propulsion Concepts was held at the Statler Hilton hotel, Boston, Mass., Oct. 7-8, 1959. Co-sponsors were the Air Force Office of Scientific Research and the Avco Corp., Avco-Everett Research Lab. The program was made up of 7 technical sessions which included a wide range of subjects related to advanced propulsion systems, and an 8th session devoted to a panel discussion of "Progress in Propulsion."

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Avco Corp. Avco-Everett Research Lab., Everett, Mass.

MAGNETOHYDRODYNAMIC ACCELERATION OF SLIGHTLY IONIZED, VISCOUSLY CONTAINED GASES, by G. S. Janes and J. A. Fay. [1959] 18p. incl. diagrs. (AFOSR-TN-59-1333) (AF 49(638)659) AD 241054 Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct. 7-8, 1959), Boston, v. 1: 19-32, 1959. (AFOSR-637)

The various physical and aerodynamic factors affecting the design of a steady flow MHD accelerator having viscous containment and crossed electric and magnetic fields are considered for the case of a slightly ionized gas. These include the effects of tensor electrical conductivity, ion slip, current diffusion, frozen flow and leaving losses, magnetic field and electrode losses, and viscous boundary layer losses. Some of these effects are also applicable to the case of a completely ionized gas. This may be the more interesting case, but it is not considered in detail. A particular example portraying most of these effects is presented for the case of a slightly ionized gas. (Contractor's abstract)

Avco Corp. Avco-Everett Research Lab., Everett, Mass.

PLASMA PROPULSION (Abstract). [1959] [1]p. (Bound with its AFOSR-TN-59-770: AD 241053) (AF 49(638)-659) Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Using the arc jet as a source of partially ionized plasma at approx 3,000°K, an isothermal accelerator has been designed which utilizes MHD forces to accelerate the gas. Currents are made to flow through the gas between electrodes placed at the top and bottom of a duct. A magnetic field perpendicular to these currents produces forces which accelerate the gas. Preliminary experiments on a scale model MHD generator are in accordance with expectations based upon estimates of gas conductivity. The MHD shock tube operates on a pulsed

basis and heats the propellant to relatively high temperatures. The basic accelerating mechanism of the MHD shock tube is that which exists in a conventional electromagnetic rail source. However, the geometry is coaxial and the acceleration takes place in the annular region containing an axial magnetic field which is used to contain the gas away from the walls. An experimental model of this apparatus has been in operation on a single pulsed basis in the specific impulse range from 10,000 to 20,000 sec. Efficient operation requires that the back voltage developed by the motion of the gas in the presence of the driving magnetic field be large compared to the arc electrode voltage drops. Experiments are currently under way to determine the electrode voltage characteristics of this device. The basic geometry of this device, coupled with a choice of particle velocities, determines the characteristic impedance and therefore a minimum instantaneous power level for efficient operation. In the MHD shock tube, frozen flow losses amount to approx 30%, since half the energy goes to heat and ionization. Investigations are also being carried out on alternative devices which avoid these limitations, including the MHD rotor.



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Bartol Research Foundation, Swarthmore, Pa.
see Franklin Inst. Bartol Research Foundation,
Swarthmore, Pa.

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Battelle Memorial Inst., Columbus, Ohio.

FINE STRUCTURE IN THE HALL COEFFICIENT, by
A. C. Beer. [1959] [5]p. incl. diagrs. [AF 49(638)222]
Unclassified

Presented at 1958 Internat'l. Conf. on Semiconductors,
Rochester U., N. Y., Aug. 18-22, 1958.

Published in Jour. Phys. and Chem. Solids, v. 8: 507-
511, Jan. 1959.

Measurements of the Hall coefficient as a function of
magnetic field in the extrinsic region of semiconduc-
tors such as p-type germanium, silicon, diamond, and
Al³b are presented confirming a fine structure consist-
ing of maxima and minima. Data is given at several
temperatures on a specimen containing 1×10^{13} extrin-
sic holes/cm³. It is pointed out that the minima is de-
pendent upon the temperature. It is also shown that
the relative prominence of the structure depends quali-
tatively on β (a measure of the degree of impurity scat-
tering) in the manner predicted by theory.

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Battelle Memorial Inst., Columbus, Ohio.

HIGH-PURITY SINGLE CRYSTALS OF INDIUM AN-
TIMONIDE (Abstract), by R. C. Baurke, S. E. Miller,
and W. P. Allred. [1959] [1]p. [AF 49(638)222]
Unclassified

Presented at [Seventh annual Spring Symposium on
Semiconductors] Philadelphia, Pa., May 3-7, 1959.

A combination zone-refining and crystal-pulling tech-
nique was developed. The indium antimonide were
purified by multiple zone passes and crystals were then
pulled from the high-purity sections of the ingot. The
same hydrogen atmosphere is used for both the zone-
refining and the pulling operations. Large, high-purity,
single crystals of indium antimonide with electron mo-
bilities over $450,000 \text{ cm}^2/\text{volt-sec}$ at 80°K can be
pulled consistently. The crystals have extremely low
dislocation densities as shown by etch-pit studies.

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Baylor U. Coll. of Medicine, Houston, Tex.

SOME MEMBRANE PROPERTIES OF THE EFFECTOR

IN THE GALVANIC SKIN RESPONSE, by R. Edelberg,
T. Greiner, and N. R. Burch. [1959] [6]p. (AFOSR-TN-
59-887) [AF 18(603)79] AD 613318 Unclassified

Also published in Jour. Appl. Physiol., v. 15: 691-696,
July 1960.

Several membrane-like properties of the effector in the
galvanic skin response (GSR) were measured in humans
by comparison of activity at a control site with that of a
site subjected to changes of external chemical environ-
ment or changes in direction or density of imposed cur-
rent. Comparison of inorganic chlorides shows that
small cations, e.g., K^+ , may reversibly reduce GSR
amplitude and R by 40%; larger cations, e.g., Ca^{++} , in-
crease GSR by several hundred per cent while at the
same time reducing basal resistance (R). GSR and R
are reduced by acids and alkalies and by detergents.
The effector is a poor rectifier, but there is a pro-
nounced effect of polarity of current on the amplitude
of the GSR in the case of large cations or anions com-
bined with smaller ions of opposite charge. Current
densities beyond $11 \mu\text{amp}/\text{cm}^2$ produce an "injury"
effect manifested in GSR and apparent resistance.
These results have been interpreted in terms of an ac-
tive superficial membrane having a relatively low
charge. (Contractor's abstract)

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Baylor U. Coll. of Medicine, Houston, Tex.

SIMPLIFIED REFERENCE CHARTS OF THE ADULT
RAT BRAIN IN STEREOTAXIC COORDINATES (Ab-
stract), by J. de Groot. [1959] [1]p. (AFOSR-TN-59-
536) (AF 49(638)384) AD 216553 Unclassified

Presented at Seventy-second annual meeting of the Amer.
Assoc. of Anatomists, Washington U., Seattle, Apr. 1-3,
1959.

Also published in Anat. Rec., v. 133: 446, Feb. 1959.

It is pointed out that an increasing number of investiga-
tions in the rat concerning the relationship of hypo-
thalamic, rhinencephalic and midbrain structures to
endocrine function has involved the use of stereotaxic
techniques. It is shown that in the absence of a standard
set of coordinates and a large scale atlas, the series of
reference charts (mapped from 50μ thick, frozen and
parasagittal sections, stained with various techniques)
may facilitate the accurate placement of electrodes and
the evaluation of results.

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Baylor U. Coll. of Medicine, Houston, Tex.

THE RAT FOREBRAIN IN STEREOTAXIC COORDI-
NATES, by J. de Groot. 1959, 40p. incl. diagrs. refs.

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(AFOSR-TN-59-537) (AF 49(638)384) AD 216554
Unclassified

Also published in *Verhandel. Koninkl. Nederl. Akad. Wetensch.*, 52: 1-40, 1959.

A presentation is made of a series of semi-diagrammatic reference charts of subcortical prosencephalic structures to facilitate the placement of stimulating, recording or lesion-inducing electrodes in the rat fore-brain. Detailed descriptions are given concerning orientation, reference points and identifying structures.

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Baylor U. Coll. of Medicine, Houston, Tex.

THE RAT HYPOTHALAMUS IN STEREOTAXIC COORDINATES, by J. de Groot. [1959] [12]p. incl. diagrs. refs. (AFOSR-TN-59-906) (AF 49(638)384) AD 234037
Unclassified

Also published in *Jour. Compar. Neurol.*, v. 113: 389-400, Dec. 1959.

Sixteen semi-diagrammatic reference charts in stereotaxic coordinates through the hypothalamus of the adult rat are presented and briefly discussed. It is hoped that these charts of basal diencephalic structures may facilitate the accurate placement of stimulating, recording or lesion-inducing electrodes and the precise evaluation of results.

77

Bell Aircraft Corp., Buffalo, N. Y.

A STUDY OF VELOCITY-FREQUENCY-DAMPING RELATIONSHIPS FOR WING AND PANEL BINARY SYSTEMS IN HIGH SUPERSONIC FLOW, by M. B. Zisfein and F. J. Frueh. Oct. 1959, 55p. incl. illus. diagrs. table, refs. (Rept. no. 9015-19-001) (AFOSR-TN-59-969) (AF 49(638)365) AD 228774; PB 145978
Unclassified

Initial results are presented of a program to obtain and study analytical relations between flutter and dynamic response. Piston theory aerodynamics was used to study 2 kinds of binary systems, pitch-plunge wings and 2-degree-of-freedom simply supported panels. A major portion of the effort was focused on the effects of viscous and structural damping on the flutter and dynamic response characteristics and the relations between them. The characteristic equations of the binary systems were derived from Lagrangean mechanics and solved for the velocity-frequency-damping relationships of these systems. From these closed-form solutions, by means of gross simplifications, several new concepts (base curve and high damping and decay asymptotes) were postulated. By comparison with exact solutions these concepts and their interrelation are shown to convey the essence of the dynamic aeroelastic stability

problem. Also from the closed-form solutions a new simple relation between flutter damping and dynamic response was derived. These new tools were then used to explain the hitherto unexplained phenomenon of loopbacks in the curves of velocity vs required damping.

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Bell Aircraft Corp., Buffalo, N. Y.

CHEMICAL NON-EQUILIBRIUM EFFECTS IN THE LAMINAR HYPERSONIC BOUNDARY LAYER, by G. R. Inger. Mar. 30, 1959, 132p. incl. refs. (Rept. no. 7010-6) (AFOSR-TN-59-237) (AF 49(638)380) AD 212007; PB 143588
Unclassified

New theoretical representations of a dissociating air mixture and a new method of non-equilibrium boundary layer solution are presented. The general governing conservation equations and attendant boundary conditions are given and discussed. The associated laminar boundary layer equations are presented, along with a consideration of the proper definition of a characteristic parameter with which the chemical non-equilibrium in the layer can be classified. Three main new features of the problem area are considered: (1) an evaluation of the comparative merits of various types of schemes approximating a dissociated air mixture is given and a more accurate and general method is proposed and developed. This new scheme is applicable to a 4-specie air mixture which is in a general state of chemical non-equilibrium; (2) the boundary layer non-equilibrium stagnation point similarity solution is reformulated in more accurate fashion according to this more accurate air mixture representation, and errors incurred by use of a lumped air atom-air molecule binary approximation of air are discussed; and (3) a new method of solving the non-equilibrium boundary layer problem is discussed, based on a chemical perturbation analysis from either frozen or thermostatic equilibrium extremes. The method permits evaluation of non-equilibrium effects over a much wider set of local conditions than is permitted by a similarity-type solution. (Contractor's abstract)

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Bell Aircraft Corp. Niagara Frontier Div., Buffalo, N. Y.

A HIGH-SPEED AND HIGH-RESOLUTION PHOTOGRAPHIC TECHNIQUE FOR THE OBSERVATION OF PROPELLANTS INJECTED INTO A FIRING COMBUSTION CHAMBER. PARTS I AND II, by T. G. Rossmann. May 18, 1959, 2v. incl. illus. diagrs. refs. (Rept. no. 8007-981-008, pts. 1 and 2) (AFOSR-TN-59-8) (AF 49(638)260) AD 208304; AD 221063; PB 143902, PB 143915
Unclassified

The objective of this investigation is to "conduct research in the general field of Observation of Burning Propellants in Rocket Engines", for the purpose of obtaining design criteria for liquid propellant rockets which

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will permit a more rational approach to design of rocket engines. The investigation shall make both theoretical and empirical approaches. For this purpose, an experimental method has been developed employing high-speed and magnifying photographic techniques in the following way. The light of a high intensity source, flashing at rates up to 10,000/sec, is directed through 2 windows in opposite walls of a rocket combustion chamber. It produces, by means of a photographic objective, a series of up to 10 consecutive magnified shadow pictures of the liquid core of the evaporating or burning propellant droplets and ligaments on a photographic film. Evaluation of these films enables one to follow the time history of the physical phenomena mentioned before which occur in a firing rocket combustion chamber. (Contractor's abstract)

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Bell Aircraft Corp. [Niagara Frontier Div.] Buffalo, N. Y.

OBSERVATION OF PROPELLANTS INJECTED INTO A FIRING ROCKET COMBUSTION CHAMBER, by T. [G.] Rossmann. [1959] [37]p. incl. illus. diagrs. refs. (AFOSR-TN-59-887) (AF 49(635)260) Unclassified

Presented at First meeting of the Joint Army-Navy-Air Force Liquid Propellant Group, New Orleans, La., Nov. 3-5, 1959.

An experimental method has been developed to gain a realistic insight into the injection and combustion processes in rocket engines by observing directly the formation and subsequent physical behavior of propellant jets and droplets during the consecutive phases of injection, impingement, atomization, evaporation, recirculation, and combustion under actual operating conditions. The method employs high speed and magnifying photographic techniques in the following way. The light of a high intensity light source, flashing at rates up to 10,000/sec, is directed through 2 windows in opposite walls of a rocket combustion chamber. It produces, by means of a photographic objective, a series of up to 10 consecutive magnified shadow pictures of the liquid core of the evaporating or burning propellant droplets and ligaments on a photographic film. Evaluation of these films enables one to follow the time history of the physical phenomena mentioned before which occur in a firing rocket combustion chamber. (Contractor's abstract)

81

Birmingham U. Dept. of Experimental Psychiatry (Gt. Brit.).

EFFECT OF DRUGS ON CONDITIONING AND HABITUATION TO AROUSAL STIMULI IN ANIMALS, by B. J. Key and P. B. Bradley. [1958] [4]p. incl. diagrs. (AFOSR-TN-59-542) (AF 61(514)1184) Unclassified

Also published in Nature, v. 182: 1517-1519. Nov. 29, 1958.

Confirmation and extension is made of previous studies concerning differential effects of certain drugs on the thresholds for arousal from sleep produced by auditory stimulation. Conscious, chronic cat preparations carrying permanently implanted cortical recording electrodes were used. Chlorpromazine, at doses of 5-10 mg/kg, produces a rise in the thresholds of both conditioned and unconditioned auditory responses, and at doses of 15-20 mg/kg, it blocked both responses. Reserpine, at a single dose of 200-250 µg/kg, produced, after a 1 - 1 1/2 hr interval, a rise in threshold for unconditioned response and later completely blocked the response, but the drug failed to significantly affect the conditioned response. Lysergic acid diethylamide caused the threshold for the unconditioned response to fall sharply but failed to affect the conditioned response threshold. Possible explanations of the data are given.

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Birmingham U. Dept. of Industrial Metallurgy (Gt. Brit.).

RESEARCH ON STRAIN-AGEING, HARDENING AND SOFTENING OF METALS BY FATIGUE. [PART I.] THE FATIGUE OF ALUMINUM-MAGNESIUM ALLOYS, by G. W. J. Waldron. [PART II.] FATIGUE OF Zn SINGLE CRYSTALS, by J. M. Summerton. Technical summary rept. Sept. 1957-Feb. 1959, 120p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-774) (AF 61(514)1182) AD 219917; PB 143959 Unclassified

Part I. Room-temperature fatigue experiments were conducted to study the conditions under which true fatigue limits occur in as-extruded Al-Mg alloys. Metallographic observations showed that increasing the Mg content reduces the width of the slip marks which occur during fatigue; the amount of surface cracking is also reduced. Subsequent to fatiguing at -196°C, tensile experiments at -196°C with intermediate resting between -80° and 20°C showed hardening and softening effects. A study of the effect of temperature on fatigue life for a given stress in Al-3% Mg indicated an increase in fatigue corresponding to the hardening effects in the fatigue-tensile experiments. Part II. A technique is outlined for growing large seeded single crystals of any desired orientation; a method is described for acid machining gage lengths in these crystals. Zn crystals of 5 different orientations were fatigued to fracture at room temperature in push-pull tests at a frequency of 100 cps. S/N curves were determined for each orientation. When the curves are replotted in terms of resolved shear stress, they superimpose, indicating that the fatigue life of a crystal is determined by the shear component of the applied stress. A few crystals which were fatigued at 50 cps showed that failure is dependent on the time of testing rather than on the number of cycles. A method was developed for measuring hysteresis loops during fatigue. The amount of plastic strain/cycle decreases with the increasing number of reversals for the first 10% of life and then remains constant for the remainder.

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Birmingham U. Dept. of Physical Metallurgy (Gt. Brit.).

THE BEHAVIOUR OF GRAIN BOUNDARIES IN METALS IN A TEMPERATURE GRADIENT, by R. W. Cahn and R. W. Lucas. Final technical summary rept. Oct. 1956-Oct. 1959, 1v. incl. illus. diagrs. refs. (AFOSR-TR-59-126) (AF 61(514)1020) AD 230161; PB 145664

Unclassified

The results of a series of investigations on grain boundary migration induced by a temperature are reported. Briefly summarized the following conclusions are reached. Grain boundary motion induced by a temperature gradient does not take place in a metal of high purity. Grain boundary motion, when it occurs at all, does so only at temperatures within a few degrees of the melting point of the solvent metal. A gradient of 1 to 2°C/cm suffices to produce movement under these conditions. Grain boundary motion can occur when appropriate solutes are concentrated at the grain boundary. This has been observed both in zinc and aluminum. The factors determining the nature and initial concentration of the solute are not known. The "driving force" for migration is always small, and surface tension forces tending to contract a curved boundary readily mask the effect in zinc. The surface area scanned by a moving boundary in zinc oxidizes faster than the body of each grain. (Contractor's abstract, modified)

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Boston U. Dept. of Biology, Mass.

THE INNERVATION AS A FACTOR IN CONTROL OF THE MICROCIRCULATION, by G. P. Fulton, B. R. Lutz, and A. B. Callahan. [1959] [15]p. incl. illus. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)44 and National Institutes of Health)

Unclassified

Presented at Symposium on Central Nervous System Control of Circulation, Washington, D. C., Nov. 1-3, 1959.

Also published in *Physiol. Rev.*, Suppl. 4, v. 40: 57-64, Apr. 1960.

Some aspects of the problem concerned with the comparative significance of direct humoral action on smooth muscle versus the role of the innervation are presented. Reference is made to investigations of the neuromotor mechanism which are concerned with the control of the microcirculation in the retrolingual membrane of the frog and the cheek pouch of the hamster. Areas where new investigations are needed in order to confirm and disprove existing assumptions are pointed out. It is believed that the innervation, at least at the peripheral level is a relatively important factor in the regulation of the microcirculation.

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Boston U. Dept. of Biology, Mass.

VASOMOTOR ADJUSTMENTS IN THE MICROCIRCULATION DURING CHANGES IN BLOOD DISTRIBUTION, by G. P. Fulton and R. F. Slechta. Final rept. Jan. 1957-July 1959, 27p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-191) (AF 49(638)44) AD 229503; PB 144789

Unclassified

Vascular responses to changes in body orientation were studied by making an investigation on the carotid sinus in golden hamsters. Using the cheek pouch preparation, it was possible to investigate by direct observation peripheral vascular responses to such blood-redistributing conditions as body orientation changes, corticosteroids and other substances produced during stress, temperature changes, hemorrhage, anoxia, etc. Pressor effects were observed after occlusion of the common carotid arteries. In body tilting experiments a carotid-sinus-like response to baroreceptor stimulation appeared to be present in the hamster. Tilting, irrespective of direction, resulted in a decreased rate of blood flow in both arterioles and venules, suggesting that the mechanisms involved are not entirely passive. Criteria were presented for the study of microcirculatory responses to environmental stresses. Studies of the relation between level of anesthesia and blood velocity were conducted to ascertain the pattern of change in velocity occurring over relatively long intervals during the period of anesthesia. Pilot experiments were performed to determine quantitatively and qualitatively by direct biochemical micro-methods the hormone production in vitro and in vivo of hamster adrenocortical tissue.

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Boston U. Dept. of Chemistry, Mass.

AN INEXPENSIVE INTEGRATING PHOTOMETER FOR MEASURING X-RAY FILM INTENSITIES, by E. L. McGandy, J. Degelman, and K. Eriks. [1959] [4]p. incl. illus. diagr. (AFOSR-TN-59-615) (AF 49(638)65) AD 221895

Unclassified

In photography it is customary to measure the blackening of photographic film quantitatively with a densitometer. In x-ray structural investigations, where precise determination of scattered radiation must be made, blackening of x-ray film is used as a measure of x-ray intensity. This may be determined by densitometry which measures the darkest part of the spot, visual comparison of the spots with a standard series, or the use of an elaborate mechanism on the x-ray camera to spread out the spot in a way that facilitates its measurement. These have both theoretical and economic drawbacks. An inexpensive integrating photometer for measuring x-ray film intensities accurately has been developed, which avoids the difficulties inherent in older methods. The photometric measurement consists of the difference between the light transmitted by an area of the film including the spot, and the light transmitted by an

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equivalent area without the spot. This difference is the so-called "integrated intensity" of the x-ray beam. The max expected error of a single integrated intensity measurement using the Integrating Photometer has been shown to be $\pm 5\%$. The total cost of the components is approx \$ 75.00.

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Boston U. [Dept. of Physics] Mass.

MODIFICATION OF THE FOKKER-PLANCK EQUATION FOR NON-LINEAR FRICTION (Abstract), by A. Siegel. [1959] [1]p. (AFOSP-TN-59-257) [AF 18(603)-29] AD 212325
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Also published in Bull. Amer. Phys. Soc., Series II, v. 4: 277, Apr. 30, 1959.

Moyal's expansion of the collision operator of the linear Boltzmann equation gives the exact basis of the Fokker-Planck equation. This expansion was studied relative to a simple model, involving 1-dimensional motion of particles of mass M in a dilute gas of molecules of mass m ($M \gg m$), in internal equilibrium ("Rayleigh model"). The Fokker-Planck equation (= Brownian motion approximation) for the distribution of particle velocities V is obtained by breaking off the Moyal expansion after the 2nd term, and taking the 2 retained "derivate moments" only to lowest order in V ; this means taking the Doppler friction (1st derivate moment) to $O(V)$. The equilibrium solution is, as is known, the Maxwell-Boltzmann distribution. If friction is taken to higher terms, say $O(V^n)$ (n odd), it can be found in this model the equation that must replace the Fokker-Planck. In order that the equilibrium distribution have the Maxwell-Boltzmann form, the Moyal expansion must be broken off after the $(n+1)$ st term, and each retained derivate moment α_k taken to $O(V^{n+1-k})$.

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Boston U. [Dept. of Physics] Mass.

[THEORETICAL STUDIES IN STATISTICAL AND QUANTUM MECHANICS] by A. Siegel. Final rept. Nov. 1959 [7]p. (AFOSR-TR-59-177) (AF 18(603)29) AD 246339
Unclassified

A brief review of the results reported under this contract is presented. Two published papers (BOS.03:001, Vol. I; BOS.03:006, Vol. II) deal with the subject of theory of fluctuations in systems with linear dissipation. A technical status report (BOS.03:005, Vol. II) was issued on the subject of quantum effects in Brownian motion. An answer to the questions concerned with a sequence of approx to the linear Boltzmann operator was also reported (item no. 87, Vol. III). Work concerned with the differential-space theory of quantum

systems has not been reported as yet, but has resulted in 2 accomplishments: (a) a new algorithm for the construction of a classical probabilistic form of quantum mechanics was developed; (b) a method was outlined for studying the temporal relaxation of ensembles whose distributions of observables differ initially from the usual quantum-mechanical form. In the area of statistical description of turbulence, a preliminary abstract has been reported (item no. 89, Vol. III). Work is continuing under contract AF 49(638)675.

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Boston U. [Dept. of Physics] Mass.

EXPANSION OF THE TURBULENT VELOCITY FIELD IN IDEAL RANDOM FUNCTIONS, II (Abstract), by W. C. Meecham and A. Siegel. [1959] [1]p. (In cooperation with Michigan U., Ann Arbor) [AF 18(603)29]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 197, Mar. 30, 1959.

The pressure term in the Navier-Stokes equations for incompressible flow is 1st eliminated. The velocity field for a member of the ensemble is then written in terms of a "power" series of ideal random functions. The necessary restrictions for the determination of the ordinary functions, K , in the expansion are obtained either by constructing correlation tensors following the method of von Karman-Howarth or from the Navier-Stokes equations directly. When only the lowest order non-vanishing terms are retained, one finds Chandrasekhar's equation (obtained by him using a different method). This result is to be expected since the velocity field to lowest order obeys a joint-normal distribution. The present method gives a systematic technique for the correction of the Chandrasekhar result. It is interesting to note that the first term also gives the first hypothesis used by Kraichnan in his work on the theory of turbulence.

90

Boulet, Georges, Toulouse (France).

DESIGN, CONSTRUCTION AND TEST OF TWO CONSTANT VOLUME COMBUSTION CHAMBERS, by G. Boulet. Technical final rept. June 30, 1959, 1v. incl. diagrs. tables. (AFOSR-TR-59-164) (AF 61(514)1162) AD 232200; PB 155570
Unclassified

The problems, methods, and results of testing 2 constant volume combustion chambers are reported. Detailed diagrams of turbines are presented along with complete calculations for determining the gain on pay load these turbines would provide. The advantages of a constant volume combustion chamber and justification for

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continuing the research in this area are pointed out. The results have convinced the investigator to start the 2nd stage of development, building a smaller combustion chamber suitable for use in automobiles and light aviation.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

ANALYTICAL METHODS IN THE THEORY OF ELECTRON LATTICE INTERACTIONS, I, by E. P. Gross. Nov. 1958, 21p. (Technical note no. 6) (AFOSR-TN-59-101) (AF 49(638)27) AD 221897
Unclassified

Also published in Ann. Phys., v. 8: 78-99, Sept. 1959.

A study is made of the low-lying levels of an electron interacting with a quantized lattice vibration field. To treat the case of arbitrary coupling strength, a canonical transformation is performed. The new lattice variables describe motions carried out partly relative to the instantaneous electron position and partly relative to the average electron state. The wave functions are assumed to be a product of electron and lattice functions in the new variables. By taking the partial expectation value with respect to electron coordinates, an effective Hamiltonian acting on the lattice variables is obtained. This Hamiltonian is brought to normal form. Corrections are obtained to intermediate coupling theory and to earlier theories of the transition between weak and strong coupling. The wave functions used are readily made the basis of a systematic perturbation theory. The relations to other methods are described and a number of generalizations noted. The approach can be directly generalized to treat more complicated Hamiltonians which involve a periodic potential, a magnetic field, or many electrons. (Contractor's abstract)

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Brandeis U. [Dept. of Physics] Waltham, Mass.

DYNAMICS OF ELECTRON BEAMS AND PLASMAS, by E. P. Gross. [1959] [26]p. incl. refs. (Technical note no. 5) (AFOSR-TN-59-102) (AF 49(638)27) AD 253127
Unclassified

Also published in Proc. Symposium on Electronic Waveguides, Polytechnic Inst. of Brooklyn, (Apr. 8-10, 1958), New York, Interscience Publishers, 1958, p. 43-61.

Many features of these systems have been treated by using one-particle velocity distribution functions. The forces acting on a particle are of 2 types: (1) a self-consistent force arising from the average effect of other particles and (2) a short-range collision force. From the results of the investigation, a clear understanding is gained of the transition from the low-pressure Knudsen gas to the hydrodynamic limit, including

the role of boundary conditions. For ionized gases there are low-pressure plasma electron and ion oscillations. At high pressures the system behaves as a single component fluid propagating acoustic waves. As the pressure is lowered there is decoupling of the charge components and finally heavy damping. A new collective method is described in which the ionized gas is treated in terms of density fluctuations, using a completely Hamiltonian theory. Distribution functions of the Fourier components of the density and their canonical conjugates are used.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

COLLECTIVE ROTATIONS OF NUCLEI, by E. P. Gross [1959] [9]p. incl. refs. (AFOSR-TN-59-1065) [AF 49(638)27]
Unclassified

Also published in Nuclear Phys., v. 14: 389-397, Jan. 1960.

An analysis is made of descriptions of collective motions of nuclei which involve the application of projection operators to a localized nuclear wave function ψ . This procedure leads to an incorrect description of center mass motion. The proposed remedy is to consider functions of the form $\psi e^{iS/\hbar}$, and to vary the functional form of the velocity potential S , subject to the constraint that the expectation value of the constant of motion has a given value for the state of collective motion. For translational motion this localized function already leads to the correct effective mass. The subsequent application of a projection operator mainly improves the zero momentum wave function. For rotational motion the velocity potential is expressed in terms of the excited states of a potential defined by ψ . The resulting moment of inertia is that of Inglis. The knowledge of the correct velocity potential for a given ψ suggests approximate functions S which express the moments of inertia solely in terms of properties of the ground ψ .

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Brandeis U. [Dept. of Physics] Waltham, Mass.

SYSTEMATIC APPROXIMATION OF THE LINEAR BOLTZMANN EQUATION (Abstract), by E. P. Gross and E. A. Jackson. [1959] [1]p. [AF 49(638)27]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 198, Mar. 30, 1959.

A systematic procedure is proposed for approximating the linear Boltzmann equation. The N^{th} approximation

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replaces the symmetric portion of the collision kernel, $K(c, c_1)$, by a bilinear series of orthonormal velocity

polynomials of order N or less. In low-order approximation the present method provides a justification of the linearized form of the equation Bhainagar, Gross, and Krook used to approximate the Boltzmann equation. This equation has been extended by Krook and Fishman, and applied to a number of problems by them and Gross, Jackson, and Ziering. Jackson showed, using this equation, that the distribution function for the Couette flow problem is a nonanalytic function of the velocity at low densities, and as a result, the flow velocity is a nonanalytic function of the mean free path λ [being of the form $(x/\lambda) \log(x/\lambda)$]. This result is not obtained by the standard method of approximating the distribution function by a polynomial expansion, as in the Chapman-Enskog or Grad schemes. The present method will likewise make it possible to treat much more accurately low-density gas dynamics, high-frequency sound propagation, and boundary value problems.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

KINETIC MODELS AND THE LINEARIZED BOLTZMANN EQUATION, by E. P. Gross and F. A. Jackson. [1959] [10]p. incl. refs. (AFOSR-4155) [AF 49(638)27] Unclassified

Published in Phys. Fluids, v. 2: 432-441, July-Aug. 1959.

Attention is directed to some unsatisfactory features of kinetic theory treatments of problems for which the linearized Boltzmann equation is applicable. The main defects are in the region where nearly free molecular flow conditions prevail. They can be overcome when the problems are treated by simplified kinetic models. In this paper relations between the linearized Boltzmann equation and some models are established. The method is based on a comparison of the eigenvalue spectra of the respective collision operators. Particular attention is paid to inverse fifth molecules. This allows evaluation of the limitations of a given model and shows how more accurate models can be constructed. It is shown how one may overcome the chief shortcomings of approx solutions of the linearized Boltzmann equation.

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Brandeis U. [Dept. of Physics] Waltham, Mass.

HEAT FLOW BETWEEN PARALLEL PLATES, by E. P. Gross and S. Ziering. [1959] [12]p. incl. diagrs. (AFOSR-4156) [AF 49(638)27] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 221, Apr. 30, 1959. (Title varies)

Also published in Phys. Fluids, v. 2: 701-712, Nov.-Dec. 1959.

A study is made of the flow of heat between parallel plates of slightly different temperatures. The problem is described by the linearized Boltzmann equation which is subject to microscopic boundary conditions. We approximate the distribution function by half-range polynomials in velocity space and determine the space-dependent coefficients by forming half-range moment equations. An approximation involving four pairs of space functions suffices to give an accurate treatment of the heat flow and of the density and temperature profiles for the entire range of conditions from free molecule to hydrodynamic. Detailed numerical results for the temperature slip and molecular boundary structure are obtained for hard-sphere molecules. The accuracy of cruder half-range approximations and other methods of fixing the coefficients is established. (Contractor's abstract)

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Brigham Young U. Dept. of Chemistry, Provo, Utah.

RHENIUM TRIOXIDE, RHENIUM HEPTOXIDE AND RHENIUM TRICHLORIDE AS HYDROGENATION CATALYSTS, by W. J. Bartley. Aug. 1958 [96]p. incl. diagrs. tables, refs. (AFOSR-TN-59-76) (AF 18(600)-1164) AD 210136; PB 142192 Unclassified

Rhenium trioxide was prepared by 3 methods, the 1st 2 involving formation of a complex between rhenium heptoxide and anhydrous dioxane and the last method, employing tetrahydropyran as a complexing agent. Reductions were carried out in a high-pressure hydrogenation vessel. The reduction products were analyzed in a gas chromatograph, by refractive indices, distillation, and/or chemical extraction, and the activities of the catalysts were determined. Results indicated that the heptoxide- and trioxide-derived catalysts were similar in their catalytic activities. The trichloride was slightly lower in its activity than the oxides. The reduction of cyclohexanone was catalyzed at 123°C with rhenium trioxide, while the heptoxide and trichloride required temperatures of about 150°C. The olefinic compounds such as 1-hexene were reduced at 95° to 100°C while styrene required slightly higher conditions due to its conjugation with the benzene ring. Nitro compounds and benzenoid compounds were the most difficult to reduce with the trioxide- and trichloride-derived catalysts. Nitrobenzene yielded aniline only below temperatures of 226° to 275°C, depending on the catalyst used. Benzene yielded slight reduction with the trichloride catalyst at 200°C. The trioxide, heptoxide, and trichloride catalysts were outstanding in their ability to reduce the carboxylic acids. In most cases, reduction was effected at 150° to 160°C. Most rhenium catalysts exhibited high activity toward the carboxyl group to some extent. The oxide catalysts

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showed an extremely high activity toward the hydrogenation of amides and anilides.

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[British Columbia U. Dept. of Mathematics, Vancouver (Canada).]

EIGENVALUE INEQUALITIES FOR FINITE MATRICES, by B. N. Moysa. Final status rept. June 1, 1956-Apr. 30, 1959. May 8, 1959, 4p. (AFOSR-TR-59-52) (AF 18(603)83) AD 215869 Unclassified

The results reported in this final report include an investigation of the maximum and minimum values of certain real valued functions where the arguments range over all sets of k orthonormal vectors in unitary n -space. A Hermitian matrix type function was examined, and extreme values of ψ were obtained when σ is a real non-negative number and when $\sigma = 1$. Several types of functions reportedly have been examined and presented in tabular form. The problem of determining the structure of any linear transformation T of M_n

having 1 or more of several properties was also analyzed.

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Brown U., Providence, R. I.

PROCEEDINGS OF THE THIRD U. S. NATIONAL CONGRESS OF APPLIED MECHANICS, Brown U., Providence, R. I. (June 11-14, 1958), ed. by R. M. Haythornthwaite. New York, American Society of Mechanical Engineers, 1958, 864p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-16) (Sponsored jointly by Air Force Office of Scientific Research under [MIPR-680-58-4], National Committee on Theoretical and Applied Mechanics, Office of Naval Research under [Nonr-245700], Office of Ordnance Research and others) Unclassified

This volume contains the complete texts of 4 invited general lectures and 97 technical papers presented at the congress. The papers are grouped by subject into 4 broad categories and arranged alphabetically, by author, within each category. Sponsors of this congress include 7 professional societies and 31 universities, institutes, federal agencies, and industrial corporations. The aim is to help maintain a high level of domestic interest in applied mechanics during the intervals between the international congresses.

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Brown U. Dept. of Physics, Providence, R. I.

A PROGRAM FOR CALCULATING ATOMIC WAVE FUNCTIONS ON THE I.B.M. 704 COMPUTER, by

M. N. Lewis. Interim rept. Oct. 14, 1958, 1v. incl. diagrs. tables. (AFOSR-TR-59-175) (AF 18(603)1554) Unclassified

A program is described for calculating self-consistent field atomic wave functions for both the original ground states and the ionized states of atoms. The methods and nomenclature used in the program follow closely those of D. R. Hartree, The Calculation of Atomic Structures, New York, Wiley and Sons, 1957. The time required by the program to compute the wave functions for an atom is estimated to be of the order of 15-20 min instead of the yr or so required by hand computing techniques. Modifications in the form of the program control and input data are necessary for the program to become generally useful.

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Brown U. Dept. of Physics, Providence, R. I.

SONICALLY INDUCED MICROSTREAMING APPLIED TO A SURFACE REACTION, by W. L. Nyborg, R. K. Gould and others. [1959] [1]p. incl. illus. diagrs. (AFOSR-TN-59-253) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)54 and National Institutes of Health under Grant RG-4431) AD 238441 Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 31: 706-711, June 1959.

Special arrangements are used to produce small-scale eddying near surfaces at which reactions are taking place. Experiments in which the reaction involves a photographic emulsion acted upon by developer show that the development process is considerably accelerated in small areas where the near-surface flow is concentrated. Resonant gas bubbles appear to be by far the most efficient sources of sonically induced microeddyding. When such a bubble rests on an emulsion surface, the development reaction in its neighborhood is significantly affected, evidently because of the local "microstirring," at ambient pressure amplitudes much less than are typically used in sonic and ultrasonic applications. Sonic microstreaming, especially as induced near resonant bubbles at boundaries, appears to be an important mechanism in accounting for certain well-known effects of ultrasound. Continued development may lead to means for applying microstreaming to surface processes in a controlled and specifiable manner. (Contractor's abstract)

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Brown U. [Dept. of Physics] Providence, R. I.

SONICALLY INDUCED MICROSTREAMING AND ITS EFFECTS ON SURFACE PHENOMENA (Abstract), by W. L. Nyborg, F. J. Jackson, and E. C. Tanner. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)54] and National Institutes of Health) Unclassified

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Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 20, Jan. 28, 1959.

A consequence of non-linearity in the hydrodynamical equations is that flow fields generated in sinusoidally vibrating boundaries exhibit time-independent circulation superposed on the oscillatory flow. Of special interest here is the steady flow induced in the immediate vicinity of boundaries. Typical speeds in this near-boundary flow tends to have their greatest values at points where there exist steep gradients of the near-surface irrotational velocity amplitude. Arrangements will be described in which vibratory sources (10 to 40 kc) are used to generate highly localized eddying near points of interest on a plane surface. Application of this small-scale eddying, or microstreaming, to surfaces at which reactions, transport activity, etc., occur shows promise as a technique for studying flow effects on such surface processes. Preliminary results have been obtained on such diverse phenomena as (1) photographic development, (2) metal etching, and (3) electrode processes.

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Brown U. [Dept. of Physics] Providence, R. I.

CAVITATION MICROSTREAMING, by S. A. Elder. [1959] [11]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)54] and Office of Naval Research) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 54-64, Jan. 1959.

In the research reported here an attempt has been made to discover by experiment what physical assumptions and approximations are appropriate in the theory of cavitation microstreaming, especially for cavitation bubbles, located near solid boundaries. A systematic investigation of the phenomenon has been made and its dependence on certain parameters (e.g., amplitude of sound) has been determined. The investigation has disclosed that as the sound amplitude is varied, other conditions remaining the same, the streaming changes discontinuously through several stable regimes. It appears that in order to account for the generation of vorticity one needs to assume different conditions at the boundaries for each regime. For at least 1 regime, a theoretical model due to Nyborg seems to be applicable; comparison is made with experimentally determined streaming velocities. (Contractor's abstract)

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Brown U. Dept. of Physics, Providence, R. I.

SMALL SCALE ACOUSTIC STREAMING NEAR A VI-

BRATING PISTON OPPOSITE A RIGID BOUNDARY (Abstract), by F. J. Jackson and W. L. Nyborg. [1959] [1]p. (AF 18(603)54) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 846, June 1959.

In studying effects of acoustic streaming on surface processes it is important to specify the flow as well as possible. One arrangement for generating localized streaming consists, in essence, of a piston of circular cross section placed in liquid a short distance above a rigid boundary. When the piston oscillates along its axis of symmetry (perpendicular to the boundary) eddying motions are observed near the tip periphery—where sharp velocity gradients exist. To permit detailed observation of the flow a large-scale low-frequency model which operates at 2 kc has been constructed. Using dark field illumination and small indicator particles, it is possible to record photographically sonically generated eddying in this case and thus determine velocity distributions. Photographs of the motion for various values of such parameters as viscosity, vibration amplitude, and piston-boundary separation will be shown. Relevant theory will be discussed.

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Brown U. Dept. of Physics, Providence, R. I.

MAGNETIC OSCILLATIONS OF ULTRASONIC ATTENUATION IN A COPPER CRYSTAL AT LOW TEMPERATURES, by R. W. Morse and J. D. Gaverda. [1959] [3]p. incl. diagrs. [AF 49(638)6] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Phys. Rev. Ltrs., v. 2: 250-252, Mar. 15, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 167, Mar. 30, 1959. (Title varies)

The magnetic field dependence of ultrasonic attenuation has been measured in a single crystal of copper where the condition $kl > 1$ is amply satisfied at liquid helium temperatures (k being the ultrasonic propagation constant and l the electron mean free path). At frequencies around 70 mc/sec several distinct maxima and minima in attenuation are found, the oscillations being in H^{-1} . With a longitudinal wave propagated along the (001) direction and H directed perpendicularly, pronounced anisotropic effects are found as H is rotated about the (001) direction. These presumably reflect anisotropy of the Fermi surface. When H is along (100) or (010) well-defined oscillations are found, which however, are largely suppressed for H along a 45° direction such as (110). This suppression is probably a result of the

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Fermi surface touching the zone boundaries in the (111) direction as suggested by Pippard. The period of the oscillations should be related directly to the Fermi momentum and reasonable values are found using a simple model. Shear waves show a pronounced phase change of the oscillations as H is rotated with respect to the direction of polarization, the effect being similar to that previously observed in a polycrystal.

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Brown U. [Dept. of Physics] Providence, R. I.

MAGNETIC DEPENDENCE OF ULTRASONIC ATTENUATION IN TIN (Abstract), by T. Olsen and R. W. Morse. [1959] [1]p. [AF 49(638)6] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 167-168, Mar. 30, 1959.

The ultrasonic attenuation due to electron interaction has been measured as a function of magnetic field in single crystals of tin where the electron mean free path is much longer than the wavelength at liquid helium temperatures. Frequencies around 50 mc/sec give pronounced oscillations from which several periods (periodic in H^{-1}) can be distinguished. These oscillations are highly anisotropic and should be related directly to the Fermi momentum. Another anisotropic effect occurs at fields of several kgauss. For some cases we find a general decrease in the attenuation with increasing field as would be expected from a simple theoretical model. However, for several orientations of the field the attenuation increases rapidly and levels off at a value higher than the 1 at zero field. It is felt that this anomalous increase with H may be related to the occurrence of open orbits for certain directions, i.e., the Fermi surface touches the zone boundaries in such a way that increasing H does not lead to localization of these electrons. An attempt will be made to deduce features of the Fermi surface of tin from these results.

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Brown U. Dept. of Physics, Providence, R. I.

EVIDENCE FOR ANISOTROPY OF THE SUPERCONDUCTING ENERGY GAP FROM ULTRASONIC ATTENUATION, by R. W. Morse, T. Olsen, and J. D. Gavenda. [1959] [2]p. incl. diagrs. [AF 49(638)6] Unclassified

Published in Phys. Rev. Lett., v. 3: 15-16, July 1, 1959.

The results given are of ultrasonic absorption measurements on single crystals of pure tin in the temperature range 1.00°K - 3.73°K. Longitudinal waves of frequencies up to 80 mc/sec were used, and different directions

of propagation were studied. It is pointed out that differences in the results for different directions may be interpreted in part as due to variations over the Fermi surface of the energy gap now associated with the superconducting state. Limiting energy gaps for various propagation directions are deduced to be: [001], $(3.5 \pm 0.1)kT_c$, [100], $(4.3 \pm 0.2)kT_c$; and [110], $(3.8 \pm 0.1)kT_c$.

The relevant portion of the Fermi surface is a cross-section at right angles to the propagation direction, and it is suggested that more than 1 energy gap may be involved.

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Brown U. Dept. of Physics, Providence, R. I.

SOME ULTRASONIC MEASUREMENTS IN NORMAL AND SUPERCONDUCTING ALUMINUM, by R. W. Morse and H. V. Bohm. [1959] [4]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)6] and Office of Naval Research) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1523-1526, Nov. 1959.

Ultrasonic attenuation measurements in an aluminum single crystal near the superconducting transition temperature are described. These include both longitudinal and shear wave attenuations at frequencies of between 11 and 58 mc/sec and at temperatures between 1.0 and 4.2°K, as well as attenuation as a function of magnetic field in the normal state. It is found that the attenuation of shear waves at the transition temperature shows a discontinuity of about 25% of the total attenuation, this fraction being relatively independent of frequency. The longitudinal wave attenuation shows a sharp but continuous drop at the transition temperature. It is shown that the electron mean free path l can be estimated from the magnetic field dependence of the attenuation and the condition $kl < 1$ ($k = 2\pi/\lambda$, λ being the ultrasonic wavelength) holds for the measurements. The possible significance of the shear wave discontinuity is discussed. (Contractor's abstract)

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Brown U. [Dept. of Physics] Providence, R. I.

FERMI SURFACE INFORMATION IN COPPER FROM ULTRASONIC ATTENUATION (Abstract), by J. D. Gavenda and R. W. Morse. [1959] [1]p. [AF 49(638)6] Unclassified

Presented at meeting of the Amer. Phys. Soc., Pasadena, Calif., Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 463, Dec. 28, 1959.

For electron mean free paths longer than the ultrasonic

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wavelength (λ) there is an oscillatory variation of ultrasonic attenuation with magnetic field (H). These oscillations, which are periodic in H^{-1} , have been previously reported in a copper crystal at 4.2°K. For H perpendicular to the propagation vector q the period of the oscillations should be determined by the external electron momentum mutually perpendicular to H and q. Thus, measurements of the periods as H is rotated about q in a single crystal should map out the Fermi surface in a plane perpendicular to q. Such measurements have been made at frequencies between 80 and 115 kc/sec and q along the [100], [110], and [111] directions. Results suggest that the surface touches the zone boundaries in [111] directions, as in Pippard's model. A long period found when H is along [111] is consistent with orbits where electrons circle around the necks of the touching regions. These indicate that touching extends over about a 20° region.

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Brown U. [Dept. of Physics] Providence, R. I.

ELECTRON RESONANCE WITH ULTRASONIC WAVES, by R. W. Morse. [1959] [1]p. [AF 49(638)6] Unclassified

Published in Internat'l. Conf. on Electronic Properties of Metals at Low Temperatures, Geneva, N. Y. (Aug. 25-29, 1958), 1959, p. 39.

Attenuation measurements at values of $q\lambda < 1$ (q = wave-number of sound wave, λ = electron free path) give useful information about the electron distribution. Thus in a magnetic field, H, the relative attenuation is $\alpha(H)/\alpha(0) = 1/[1 + (2\omega_c\tau)^2]$ where $\omega_c = eH/m^*c$ is the cyclotron frequency of free particles of mass m^* , and τ is the relaxation time. Hence for Cu, τ is estimated in a particular specimen from attenuation measurements as 3.8×10^{-11} sec, and, using the Fermi velocity for free electrons, gives $\lambda = 7 \times 10^{-3}$ cm. From the general dependence of α on $q\lambda$, using Pippard's free electron theory without an H field, the region of $q\lambda = 1$ can be identified where the curve changes character. Hence λ can be deduced from the frequency (10 mc) giving $\lambda = 6 \times 10^{-3}$ cm for the specimen Cu. At large $q\lambda$, in an H field, oscillatory attenuation is found. The oscillation periods are simply related to electronic properties and offer a more promising way of obtaining information about the Fermi surface, than the above procedures. The results are now independent of λ , and give information about R/λ where R is the cyclotron radius, $P_\perp C/eH$ (P_\perp = momentum of electron transverse to H), and λ the sound wave length. The basic rule for the oscillation periods proposed by Pippard is that the diameter of the orbit changes λ in one period; hence an average P_\perp can be evaluated for a particular direction in the crystal. Anisotropy in P_\perp can then be studied.

Measurements have been carried out on Cu and Sn, leading to reasonable estimates of P_F (the Fermi momentum).

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Brown U. [Dept. of Physics] Providence, R. I.

ULTRASONIC ATTENUATION OF SHEAR WAVES IN SUPERCONDUCTORS, by R. W. Morse and H. V. Bohm. [1959] [2]p. [AF 49(638)6] Unclassified

Published in Internat'l. Conf. on Electronic Properties of Metals at Low Temperatures, Hobart Coll., Geneva, N. Y. (Aug. 25-29, 1958), 1959, p. 20-21.

The observed rapid decrease of attenuation of ultrasonic longitudinal waves, on going into the superconducting state, has previously been shown to agree with a prediction of the ECS (J. Bardeen, L. Cooper and J. Schrieffer, Phys. Rev., v. 108: 1175, 1957) theory. The simple result of calculating the energy lost by the sound wave through scattering electrons between stages of the superconductor, is $\sigma_s/\sigma_n = 2/\exp(E_0/kT) + 1$ where $2E_0$ is the temperature-dependent energy gap in the one-particle spectrum, and σ_s, σ_n are attenuations in the superconducting and normal states. Thus the attenuation drops sharply but continuously below T_c because of the increasing energy gap. Measurements on Sn single crystals with 51 mc/sec longitudinal waves along [001] agree strikingly well with this formula. Shear waves, however, show a remarkable new feature in their attenuation, namely, a discontinuous drop at T_c , and then a continuous fall with decreasing T. Thus a polycrystal of Sn with 27.5 mc/sec shear waves shows a 55% drop at T_c in an interval less than 0.01 K°, whereas in the next 0.02 K° the attenuation falls only 4%. The gradually decreasing part then agrees with the BCS formula above. Similar results are shown in measurements with In and Al.

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Brown U. Dept. of Physics, Providence, R. I.

ULTRASONIC ATTENUATION IN METALS AT LOW TEMPERATURES, by R. W. Morse. [1959] [39]p. illus. diagrs. tables, refs. [AF 49(638)6] Unclassified

Published in Progress in Cryogenics, v. 1: 221-259, 1959.

Recent low-temperature observations of ultrasonic attenuation have shown that it is possible to observe directly the interaction of a plane harmonic lattice wave with the conduction electrons in metal. This paper reviews the current status of this method, and discusses in some detail the experimental techniques used. The theory of attenuation by conduction electrons is

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considered, including phonon-electron scattering, relaxation and viscosity approximations, the attenuation for an arbitrary mean free path, and attenuation in the superconducting state. The experimental results deal with attenuation in the normal and superconducting states, and with the magnetic-field dependence of attenuation.

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Brown U. Div. of Applied Mathematics, Providence, R. I.

CALCULATION OF SUPERSONIC FLOW PAST A FLAT-HEAD CYLINDER BY BELOTSEKOVSKII'S METHOD, by R. Gold and M. Holt. Mar. 1959, 21p. incl. diagrs. tables. (AFOSR-TN-59-199) (AF 49-(638)232) AD 211525; PB 139947 Unclassified

Belotserkovskii's method of calculating the supersonic flow past a circular cylinder is applied to the case of a flat headed cylinder. The surface pressure distribution and associated flow field (including the shape of the detached shock wave) are determined for a prescribed incident Mach number. Only the 1st approximation of Belotserkovskii is considered. Selected physical variables are assumed to vary linearly between the body and the shock, thereby reducing the original problem to 1 of solving 3 ordinary differential equations. The boundary conditions are obtained from symmetry conditions on the axis of symmetry, the oblique shock equations and the condition that sonic speed is attained at the sharp shoulder. (Contractor's abstract)

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Brown U. Div. of Applied Mathematics, Providence, R. I.

SUPERSONIC PANEL FLUTTER OF A CYLINDRICAL SHELL OF FINITE LENGTH, by S. L. Strack and M. Holt. May 1959, 56p. incl. diagrs. refs. (AFOSR-TN-59-547) (AF 49(638)232) AD 216693; PB 142404 Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 197-208, Mar. 1961.

Panel flutter characteristics of cylindrical shells of finite length in a uniform supersonic stream are determined. The aerodynamic term is found for a finite cylinder, and the corresponding shell equation is an integro-differential equation of 4th or 8th order. This is very difficult to solve as it stands but can be reduced to a differential equation by means of a plausible assumption about the behavior of the aerodynamic term. This simplified equation is solved, and the results are compared with those of earlier calculations. In general, it is found that the use of a more realistic aerodynamic term leads to higher estimates of critical flutter Mach numbers. (Contractor's abstract)

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Brown U. Div. of Engineering, Providence, R. I.

AN APPROXIMATE SOLUTION FOR TRANSONIC FLOW IN CASCADES, by A. D. Wood and J. H. Clarke. [1959] [1]p. (AF 18(600)654) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 318-319, May 1959.

Treatment is made of the steady, isentropic, isocnergetic, transonic flow equation through an unstaggered, non-lifting, 2-dimensional cascade of slender airfoils. The equation assumes a form affinely related to Poisson's equation which treats the problem as a 1-dimensional flow through the cascade. The final formula for the coefficient of pressure is easily obtained, and comparison of theoretical and experimental results is particularly good.

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Brown U. [Div. of Engineering] Providence, R. I.

THE EFFECT OF PRESSURE ON THE VISCOSITY OF N_2 - CO_2 MIXTURES, by J. Kestin and W. Leidenfrost. [1959] [12]p. incl. diagrs. tables. (AFOSR-TN-59-393) (AF 18(600)891) AD 214513 Unclassified

Also published in Physica, v. 25: 525-536, July 1956.

Precise measurements of the viscosity of the binary mixture N_2 - CO_2 at 20°C over a range of pressures from 1 to 21 atm are given. The viscosity was measured with the aid of an oscillating-disk viscometer developed by the authors. The measurement was an absolute one with an estimated accuracy of 0.05%. The composition of the mixtures was determined from the measured pressures during filling with the aid of the Benedict-Webb-Rubin equation. It is believed that the molar fractions were determined with an uncertainty of 1%. This is by far the largest uncertainty of the measurements. The pressure effect on the viscosity of the pure components at 20°C was determined in the same instrument leading to internally consistent data. A comparison is made with Wilkes' equation for the viscosity of binary mixtures but the deviations from proportionality predicted by it are opposite to those measured. No comparison with the results of calculations based on inter-molecular potentials were possible. (Contractor's abstract)

117

Brown U. [Div. of Engineering] Providence, R. I.

THE VISCOSITY OF HELIUM, by J. Kestin and W. Leidenfrost. [1959] [19]p. incl. diagrs. tables, refs. (AFOSR-TN-59-394) [AF 18(600)891] AD 214514 Unclassified

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Also published in *Physica*, v. 25: 537-555, July 1959.

Measurements of the viscosity of helium are investigated in the range of pressures of 1-137 atm and in the range of temperatures of 25-237°C with an accuracy of from 0.2% at lower temperatures to 0.5% at higher temperatures. The method used was that of a disk oscillating between 2 plates with moderate gaps, and the measurements were relative to nitrogen. The results show no significant pressure effect. The temperature effect has been correlated empirically by the use of Keesom's and Keyes formulas as well as by the use of the methods of statistical mechanics, i.e. with the aid of the Lennard-Jones, 6-12, and the modified Buckingham, exp-6, potentials. It appears that the best fit is obtained with the aid of the exp-6 potential. If an accuracy of 1% only is required, then there is little to choose between the various schemes up to 800°C. Keesom's formula spans the widest range of temperatures. (Contractor's abstract)

118

Brown U. [Div. of Engineering] Providence, R. I.

REVIEW OF AVAILABLE EXPERIMENTAL DATA ON THE VISCOSITY OF STEAM, by J. Kestin and J. R. Moszynski. [1959] [8]p. incl. diagrs. table, refs. [AF 18(600)891] Unclassified

Presented at Symposium on Thermophysical Properties, Purdue U., Lafayette, Ind., Feb. 23-26, 1959.

Also published in *Thermodynamic and Transport Properties of Gases, Liquids and Solids*, ed. by Y. S. Touloukian, New York, Amer. Soc. Mech. Engineers; McGraw-Hill, 1959, p. 70-77.

A critical review of existing experimental data on the viscosity of steam and compressed water is presented. At low pressures, i.e., up to about 1 atm, the existing data correlate with an estimated accuracy of $\pm 1.5\%$ with the aid of the equations

$$\mu = \frac{25.64}{1 + \frac{1371}{T} \times 10^{-37.4/T}} \times 10^{-6} \text{ poise for } T < 1100^\circ\text{C}$$

$$\text{and } \mu = \frac{14.98}{1 + \frac{24.51 \times 10^4}{T^2}} \times 10^{-6} \text{ poise for } T > 1100^\circ\text{C}.$$

It is hoped that the 2nd of these equations may offer a reasonable means for extrapolating to, say, 2000°C. At higher pressures new and more reliable data will be required before any reasonable correlations may be attempted. (Contractor's abstract, in part)

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Brown U. Div. of Engineering, Providence, R. I.

TESTS OF A CONFIGURATION COMPOSED OF A BODY UNDER A LIFTING WING IN SUPERSONIC FLOW, by C. F. Chen. Feb. 1960 [10]p. incl. illus. diagr. (Technical rept. no. WT-31) (AFOSR-TN-59-1275) (AF 49(638)444) AD 233944; PB 146438

Unclassified

Also published in *Jour. Aero/Space Sci.*, v. 28: 547-562, July 1961. (Title varies)

Tests were made on an arrangement consisting of a Sears-Haack body located under a lifting rectangular diamond profile wing. The Mach number was 1.6 and the Reynolds number was 9.17×10^5 based on the body length. The experiments were suggested by a previous theoretical study of such arrangements. It is found that the measured lift developed on the wing due to the flow field of the body agrees very well with the theoretical value. Downstream of the impinging shock from the wing, flow separation was observed on the exterior side of the body but not on the interior side. The separation is attributed not to the pressure rise across the shock but to the pressure field arising from the reflection from the body of the shock-induced cross flow. Further observations suggest that the separation can be avoided by pitching the body or by kinking the body at the shock wave to accommodate the shock-induced cross flow. (Contractor's abstract)

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Brown U. Div. of Engineering, Providence, R. I.

A STUDY OF CONFIGURATIONS COMPOSED OF A BODY UNDER A LIFTING WING IN SUPERSONIC FLOW, by C. F. Chen and J. H. Clarke. Jan. 1960 [62]p. incl. diagrs. table, refs. (AFOSR-TN-59-1276) (In cooperation with Johns Hopkins U., Silver Spring, Md.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)444 and Bureau of Weapons under NOrd-7386) AD 233523; PB 146437

Unclassified

Also published in *Jour. Aero/Space Sci.*, v. 28: 547-562, July 1961. (Title varies)

An investigation is made of supersonic aircraft configurations composed of a cambered body positioned a certain distance beneath an arbitrary lifting wing. The geometry of the wing is regarded as given and the geometry of the body may be given or optimum. Expressions for the drag and lift are obtained from reverse-flow considerations; these greatly implement such a study when interference cross-flows must be cancelled. The drag advantage to be gained when a given body and wing assume a given orientation is studied. Treated more extensively is the variational problem of determining the optimum wing incidence and optimum body

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shape, for the given volume and length, to yield the minimum drag for prescribed lift. Numerical results are provided to indicate the significance of the large number of parameters appearing in the problem. Of these the gap between the wing and the body is found to be particularly important. It is found at low gap that moderate body distortions have a significant influence on the drag. Drag reductions of up to 44% relative to the case of no interference have been found at $M = 2.24$ in a configuration having a gap approximately equal to the maximum diameter of the body, a wing chord of about $3/8$ of the length of the body. Comparison is made with the conventional wing-body combination with the effects of skin friction included, and it is concluded that the advantage suggested by the preceding considerations is not appreciably diminished. Finally, it is shown that the configurations studied lead to bodies of much lower fineness ratios than appropriate in conventional wing-body combinations. (Contractor's abstract)

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Brown U. Div. of Engineering, Providence, R. I.

ON THE APPLICATION OF THE URSELL-WARD THEOREM TO WINGS WITH EDGE FORCES, by J. H. Clarke. [1959] [2]p. (AF 49(638)444) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 535-536, Aug. 1959.

The way in which the Ursell-Ward reverse flow theorem must sometimes be modified to account for edge forces on wings is shown and several applications of this modified theory are considered. It is pointed out that the inference made by Yoshihara (Jour. Aero/Space Sci., v. 25: 600, Sept. 1958) that the downwash criterion is invalid when edge forces are present, and deduction based on this conclusion are the result of an incorrect application of the theorem. It is further demonstrated that the downwash criterion does hold for such cases.

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Brown U. Metals Research Lab., Providence, R. I.

ORIENTATION OF RECRYSTALLIZED GRAINS IN STRAINED ALUMINUM SINGLE CRYSTALS, by H. Yoshida, B. [G.] Liebmann, and K. Lücke. [1959] [6]p. incl. illus. diagrs. table, refs. (AFOSR-4393) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)75 and Office of Naval Research under Nonr-56212) Unclassified

Published in Acta Metall., v. 7: 51-56, Jan. 1959.

Artificially nucleated crystals were grown in strained aluminum single crystals by cutting them at one end with pliers and then subjecting them to recrystallization heating. An overwhelming majority of the new crystals showed an orientation characterized by a 40° rotation

around the $[1\bar{1}1]$ axis relative to the old matrix. After further heating most of the fine grains disappeared and only one crystal finally occupied the full diameter of the wire. Laue and Debye-Scherrer x-ray photographs indicated that the preferred orientation of the final crystals originates in growth selection. The preference of the $[1\bar{1}1]$ among the other 111 axes may be caused either by the plastic deformation of the old matrix or by the fact that the boundary between the two crystals is a pure tilt boundary if both have a common $[111]$ axis.

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Brown U. Metals Research Lab., Providence, R. I.

MULTIPLE SCATTERING OF ELASTIC WAVES INVOLVING MODE CONVERSION, by B. Raphael and R. Truell. May 15, 1959 [54]p. incl. diagrs. tables. (AFOSR-TN-59-399) (AF 49(638)450) AD 214519; PB 142001 Unclassified

The equations of multiple scattering derived by Waterman and Truell [Technical rept. WAL 143/14-49, Oct. 1957] are applied to problems of scattering of elastic waves by a random array of identical spherical obstacles with mode conversion treated explicitly. In the multiple scattering of a plane compressional wave, mode conversion is shown to introduce only negligible corrections to the modified phase velocity and attenuation expressions found by Waterman and Truell. In the multiple scattering of a plane shear wave it is shown that no single overall modified phase velocity or attenuation exists since the wave motion in the scattering medium does not maintain the form of a plane wave. The incident plane shear wave after scattering is found to be resolved into a series of component waves, which are difficult to describe physically, and each of which propagates with its own independent phase velocity and attenuation. Formulas for the propagation parameters of each scattered component wave are developed in terms of constants which may be found from appropriate single-scattering problems, and these constants are evaluated for the case in which the scatterers are elastic spheres. (Contractor's abstract)

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Brown U. Metals Research Lab., Providence, R. I.

INVESTIGATIONS ON RECRYSTALLIZATION AND RECOVERY OF STRAINED ALUMINUM SINGLE CRYSTALS, by R. Green, Jr., H. Yoshida, and B. [G.] Liebmann. Apr. 30, 1959 [74]p. incl. illus. diagrs. refs. (AFOSR-TN-59-381) (AF 49(638)479) AD 214008; PB 140996 Unclassified

The influence of the state of impurities (dissolved in solid solution or precipitated) on the recrystallization of extended Al single crystal wires was investigated. The crystals contained 99.79% Al, 0.09% Fe, 0.09% Si, and 0.03% Zn; only the Fe was not well within its

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solubility limit. No preferred orientations were obtained when the crystals were annealed for several hours at 620°C prior to deformation. Upon reheating below 500°C, the yield point of the crystals increased, reached a maximum, and finally decreased. Recrystallization produced preferred orientations in samples which were reheated until the maximum yield point was reached or exceeded. This result indicates that Fe in supersaturated solid solution prevented the generation of preferred orientations while it had no effect of this kind when precipitated. The initial growth rate of strain-free nuclei into deformed matrices was also strongly dependent on the state of Fe; the larger the Fe precipitates, the faster was the initial growth rate. Curves of recovery of the growth rate vs reheating time showed a maximum at the same point as the yield point curve. These curves indicate that recovery was greatest when Fe precipitates were at a critical size and separation; these precipitates produced the maximum hardness. The growth rate of new crystals increased as the amount of extension of the matrix crystals was increased. (ASTIA abstract)

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Brown U. Metals Research Lab., Providence, R. I.

INFLUENCE OF BOUNDARY ORIENTATION ON GROWTH RATES IN RECRYSTALLIZATION, by H. Yoshida, N. Pitula, and B. [G.] Liebmann. Apr. 30, 1959 [10]p. incl. diagrs. table. (AFOSR-TN-59-382) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)479 and Office of Naval Research under Nona-56212) AD 214009; PB 140995
Unclassified

The influence of the orientation of grain boundaries on their mobility during recrystallization was investigated. Thin rods of 1.5 mm x 1.5 mm cross section were cut from strained aluminum single crystal sheets and artificially nucleated at one end. Due to the surface tension of the interfaces the boundaries always took a position normal to the rod axes. Therefore it was possible to produce boundaries of various orientations by cutting the rods in different crystallographic directions. Since the sheet crystals were extended prior to cutting, the distribution of dislocations in the rods was independent of the rod axes. This is an advantage over extended single crystal wires where the normal to the grain boundary and the direction of extension always coincide. Growth rates and preferred orientations after recrystallization were investigated for various boundary orientations. The results provide evidence that the orientation of the boundary may have a strong influence on its mobility during recrystallization. In the case of 40° <111> orientation relations between new and deformed crystals, the rate of boundary migration changes by a factor of 45 due to variations in the orientation of the boundary. The dependence of the growth rates of 40° <111> rotated new grains on the orientation of their grain boundaries contradicts attempts to explain high growth rates on the basis of common lat-

tice sites and suggests that edge dislocations play an important role in the structure of boundaries with high mobility. (Contractor's abstract)

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Brown U. Metals Research Lab., Providence, R. I.

STATUS REPORT ON RECRYSTALLIZATION TO MARCH 31, 1959, by B. G. Liebmann. Technical rept. Apr. 15, 1959, 5p. (AFOSR-TR-59-63) (AF 49(638)-479) AD 217009; PB 142302
Unclassified

The work performed under this contract is described in 3 technical notes (see item nos. BRO.14:001, Vol. II, and item nos. 124 and 125, Vol. III). The present rept. gives abstracts of these publications in addition to possible areas for further study.

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Brown U. Metcalf Research Lab., Providence, R. I.

STATISTICAL-MECHANICAL THEORY OF TRANSPORT IN FLUIDS, by H. Mori. [1958] [14]p. incl. refs. (AFOSR-TN-59-548) (AF 18(603)87) AD 264299
Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Mar. 27-29, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 104, Mar. 27, 1958.

Also published in Phys. Rev., v. 112: 1829-1842, Dec. 15, 1958.

A statistical-mechanical theory of transport processes in fluids of g components is presented on the assumption that the macroscopic state of the system can be described by 1 velocity, 1 temperature, and g mass-density fields. The formulation is based on the explicit recognition of the fact that there are 2 relaxation processes in fluids: one is the macroscopic process of attaining spatial uniformity and is represented by the hydrodynamical equations, whereas the other is the microscopic process of attaining internal thermal equilibrium in small mass elements of macroscopic size and determines the transport coefficients. For instance, in dilute gases the microscopic process is the relaxation process in momentum space. The coupling of the 2 processes is investigated to obtain the dissipative terms in the transport equations with the aid of the correlation function method outlined in a previous paper. The hydrodynamical equations, the equation of entropy balance, and the linear relations between the thermodynamic fluxes and affinities are thus derived with explicit expressions for the coefficients of viscosity, thermal conductivity, and diffusion, which are valid for liquids as well as for gases. The classical limits of these

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expressions, $h \rightarrow 0$, are somewhat different from those obtained by Green for classical mechanical systems. (Contractor's abstract)

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Brown U. Metcalf Research Lab., Providence, R. I.

CORRELATION FUNCTION METHOD FOR TRANSPORT PHENOMENA, by H. Mori. [1959] [3]p. [AF 18(6C3)87] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 275, Apr. 30, 1959.

Also published in Phys. Rev., v. 115: 298-300, July 15, 1959.

An expression for the nonequilibrium density matrix is derived in terms of dynamical fluxes, which leads to a rigorous formulation of the correlation function method for transport phenomena with nonuniform thermodynamic quantities.

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Brown U. Metcalf Research Lab., Providence, R. I.

DIELECTRIC RELAXATION OF POLAR LIQUIDS, by S. H. Glarum. [1960] [5]p. incl. refs. [AF 49(638)31] Unclassified

Published in Jour. Chem. Phys., v. 33: 1371-1375, Nov. 1960.

The statistical theory of the dielectric relaxation of polar liquids is developed using the fluctuation-dissipation approach to linear dissipative phenomena, and an expression is derived relating the complex dielectric constant to a time-dependent microscopic correlation function. It is found that a finite number of microscopic relaxation times leads to an equal number of macroscopic decay times, and, in the case of a single relaxation time τ_0 , the decay time is given by $T_0 =$

$[3\epsilon_0/(2\epsilon_0 + \epsilon_\infty)]\tau_0$, ϵ_0 being the static dielectric constant, and ϵ_∞ being the high frequency dielectric constant. Relaxation times are also determined for systems having 2 decay times, and for systems characterized by the circular-arc and skewed-arc distribution functions. (Contractor's abstract)

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Brown U. Metcalf [Research] Lab., Providence, R. I.

THE HIGH TEMPERATURE PYROLYSIS OF

ACETYLENE 1400-2500°K, by C. F. Aten and E. F. Greene. May 1959 [30]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-514) (AF 49(638)167) AD 253124 Unclassified

Also published in Combust. and Flame, v. 5: 55-64, Mar. 1961.

The pyrolysis of acetylene-argon mixtures has been investigated in the temperature range 1400 to 2500°K by using shock wave heating. Time resolved emission and absorption spectra, measurements of reflected shock velocities, and analysis of the products of the reaction have been used to follow the rate of loss of acetylene. The average activation energy from 600 to 2600°K is approximately 39 kcal/mol and there is evidence that the same mechanism is dominant over the whole range. (Contractor's abstract)

Brussels U. (Belgium) see Free U. of Brussels (Belgium)

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Burden Neurological Inst. [Physiological Dept.] Bristol (Gt. Brit.).

AN AMBIGUITY OF BIPOLAR RECORDING, by R. Cooper. [1959] [2]p. [AF 51(514)1178] Unclassified

Published in EEG Clin. Neurophysiol., v. 11: 819-820, 1959.

Consideration is given to the use of differential (push/pull) amplifiers for phase or time comparison of periodic functions and possible misinterpretation of the results.

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Burden Neurological Inst. [Physiological Dept.] Bristol (Gt. Brit.).

INTRINSIC RHYTHMS OF THE BRAIN, by W. G. Walter. [1959] [20]p. incl. illus. diagrs. refs. [AF 61-(514)1178] Unclassified

Published in Handbook of Physiol., v. 1: 279-298, 1959.

The main sources of rhythmic activity are illustrated by 2 simple mechanical models and their electric equivalents: (1) a pendulum, illustrating simple harmonic oscillation, and (2) the autosiphon, an elementary example of relaxation oscillation. Alpha rhythms are the most prominent and peculiar features of human brain activity and are considered representative of rhythmic activity under normal conditions. Their appearance in normal people is usually suggestive of intrinsic complexity. It is generally true that the amplitude of spontaneous rhythms in the alpha category is inversely correlated with visual attention. The acceptable frequency range is 8-13 cps. Experiments with a toposcope

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display system, used to record the effect of mental activity on alpha frequency and distribution in a normal subject, demonstrated that alpha activity exhibits extreme constancy in frequency under tranquil conditions, but during activity, there is a marked independence of the hemispheres of the brain and of adjacent regions. Discussion is presented on 3 other main classes of rhythm: (1) theta rhythms, with a frequency of 4-7 cps, occupying typically the parietal and temporal regions of the brain, and associated with childhood and emotional stress in some adults; (2) delta rhythms, with frequencies from less than 1 up to 3 cps, associated with deep sleep in normal adults, with infancy, and with organic brain disease; and (3) beta rhythms, with frequencies higher than 14 cps, generally associated with activation and tension.

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Burden Neurological Inst. [Physiological Dept.]
Bristol (Gt. Brit.).

A SIMPLE ELECTRODE SELECTOR SYSTEM. by R. Cooper and W. J. Warren. [1959] [2]p. [AF 61(514)-1178] Unclassified

Published in EEG Clin. Neurophysiol. v. 11: 810-811, 1959.

A description is presented of an electrode selector system which can be used for connecting a selection from 88 electrodes to any of 30 differential amplifiers either bipolar fashion or with respect to the average potential of all electrodes. Provision is also made for connection to and from transducers so that polygraphic recording of autonomic variables can be made.

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Bureau of Mines, Bartlesville, Okla.

THE PRESSURE-VOLUME-TEMPERATURE PROPERTIES OF PERFLUOROCYCLOBUTANE. EQUATIONS OF STATE, VIRIAL COEFFICIENTS, AND INTERMOLECULAR POTENTIAL ENERGY FUNCTIONS, by D. R. Douslin, R. T. Moore, and G. Waddington. May 1959 [30]p. incl. diagrs. tables, refs. (Contribution no. 99) (AFOSR-TN-59-493) (CSO-680-57-4) AD 215846 Unclassified

Also published in Jour. Phys. Chem., v. 63: 1959-1966, Nov. 1959.

Studies of the pressure-volume-temperature properties of perfluorocyclobutane in the ranges, 3-394 atm, 30-350°, yielded values of gas compressibility, critical constants, vapor pressure and orthobaric liquid and vapor densities. The results were correlated by the Beattie-Bridgeman, Benedict-Webb-Rubin, and Martin-Hou equations of state, and by the Stockmayer and the Kihara intermolecular potential energy functions. The merits of the several correlational methods are discussed.

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Bureau of Mines, Bartlesville, Okla.

PVT AND COMBUSTION STUDIES ON FLUOROCARBONS, by D. R. Douslin, W. D. Good and others. Final rept. Dec. 1, 1958-Mar. 1, 1959. Mar. 31, 1959, 22p. incl. tables, refs. (AFOSR-TR-59-42) (CSO-680-57-4) AD 214510 Unclassified

In this report the accomplishments of the project are summarized, and their significance discussed. Also, some of the areas in which future work on the thermodynamic properties of organic fluorine compounds would be most beneficial are outlined.

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Bureau of Mines, Bartlesville, Okla.

COMBUSTION CALORIMETRY. I. ORGANIC FLUORINE COMPOUNDS, by W. D. Good and D. W. Scott. Aug. 3, 1959. 34p. incl. diagrs. tables, refs. [CSO-680-59-9] AD 219968; PB 146580 Unclassified

The contents of this technical note are to appear as a chapter in the book "Experimental Thermochemistry, Vol. II," being prepared under auspices of the Sub-Commission on Experimental Thermochemistry of the International Union of Pure and Applied Chemistry. The combustion calorimetry of organic fluorine compounds is discussed, and experimental procedures are recommended. A computation form is given for reducing the experimental results to standard states. Also discussed are factors influencing accuracy, choice of reference substances, and publication of results. (Contractor's abstract)

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Bureau of Mines, Bartlesville, Okla.

COMBUSTION CALORIMETRY. II. ORGANO-METALLIC COMPOUNDS, by W. D. Good and D. W. Scott. Aug. 3, 1959, 30p. incl. tables, refs. (AFOSR-TN-59-699) [CSO-680-59-9] AD 219970; PB 146601 Unclassified

The contents of this technical note are to appear as a chapter in the book "Experimental Thermochemistry, Vol. II," being prepared under auspices of the Sub-Commission on Experimental Thermochemistry of the International Union of Pure and Applied Chemistry. The combustion calorimetry of organometallic compounds and other carbon compounds of metals is discussed. References are given to past work in the field. Limitations of static-bomb methods and advantages of rotating-bomb methods are pointed out. Other topics treated are: Corrections to standard states; comparison experiments; materials for the bomb, fittings and crucible; containers for samples; problem of complete combustion; and publication of results.

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[Bureau of Mines, Pittsburgh, Pa.]

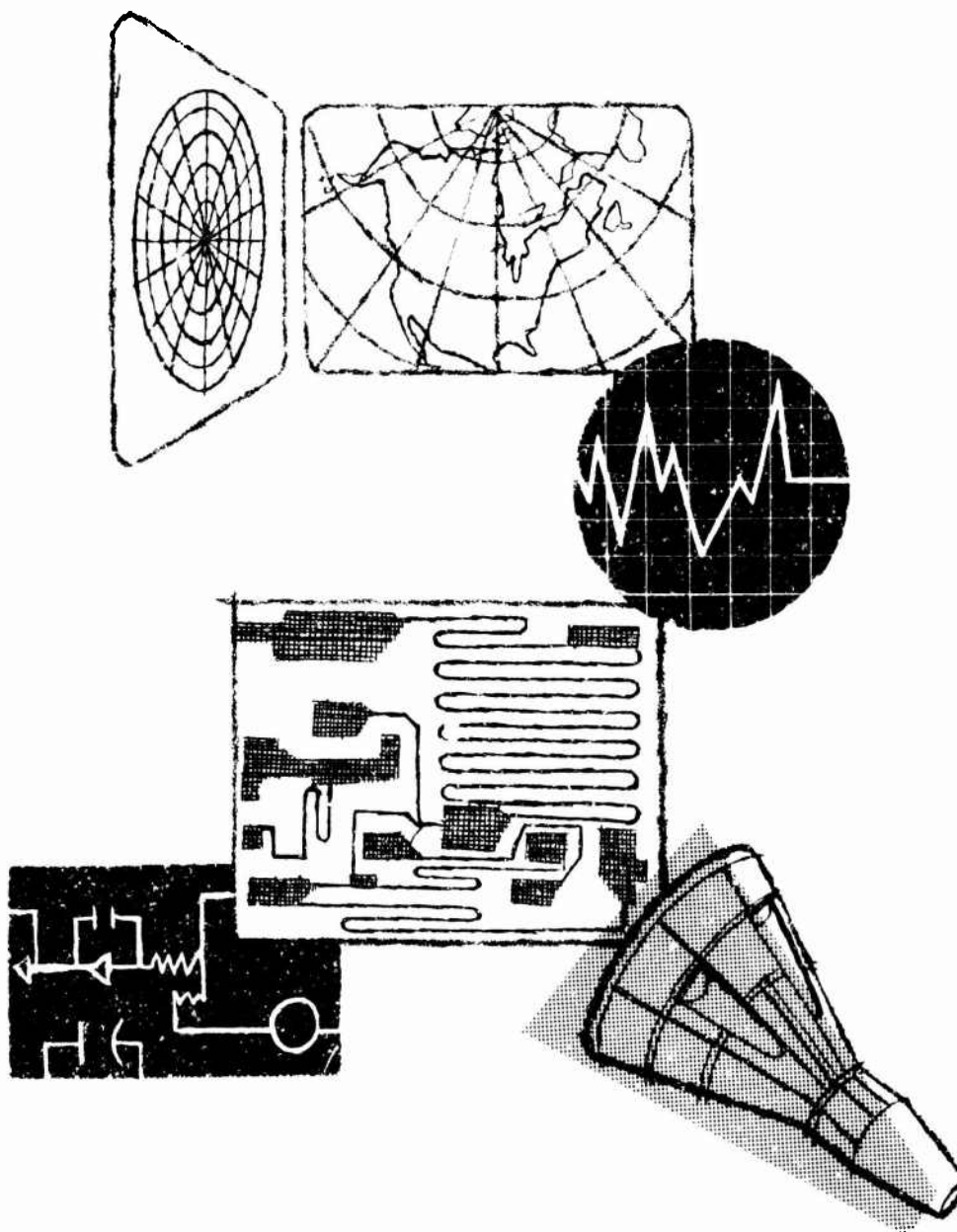
TURBULENT FLAME PROPAGATION BY LARGE-SCALE WRINKLING OF A LAMINAR FLAME FRONT,
by J. K. Richmond, J. Grumer, and D. S. Burgess.
[1959] [6]p. incl. illus. diagrs. (CSO-680-58-10)

Unclassified

Published in Seventh Symposium (Internat'l.) on Com-

bustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, p. 615-620.

Photometric and electronic probe studies were made of wrinkled laminar flames in the wake zone of a 1-1/4 in. diam burner rim. The salient characteristics of the flames are summarized, including flame structure, spatial distribution and average levels of flame radiation, and turbulent burning velocities.



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California Inst. of Tech. [Antenna Lab.] Pasadena.

ELECTROSTATIC ION-OSCILLATIONS OF A HIGH-DENSITY PLASMA, by H. T. Ozaki and C. H. Papas. [1959] 11p. (AFOSR-TN-59-233) [AF 18(600)1113] AD 212003 Unclassified

The positive-ion oscillation of a high-density plasma excited by an injected ion are examined under the assumptions that the plasma ions constitute an electrically charged fluid and that the plasma electrons at each instant have the equilibrium distribution in the electrostatic potential due to the electrical charge of the fluid, the electrons, and the injected ion. A dispersion relation for the electro-acoustic waves is derived, and the spatial rate of decrease of the kinetic energy of an injected ion is calculated. (Contractor's abstract)

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California Inst. of Tech. Antenna Lab., Pasadena.

ASYMMETRICALLY EXCITED ELECTROMAGNETIC RADIATION FROM CIRCULAR CYLINDERS OF FINITE LENGTH AND PROLATE SPHEROIDS, by H. H. Kuehl. June 1959, 113p. incl. illus. diagrs. refs. (Technical rept. no. 19) (AFOSR-TN-59-595) (AF 18(600)1113) AD 217182 Unclassified

The far zone radiation from 2 types of asymmetrically excited systems is considered. The 1st is a finite cylinder excited by an electric dipole in the radial direction near the cylinder. The 2nd is a prolate spheroid excited by a narrow belt of electric field around the surface of the spheroid. In both cases the body considered is perfectly conducting and the excitation is not necessarily centered at the midplane of the body. In the case of the finite cylinder excited by a radial dipole, an approximate method is used in which the current on the finite cylinder is taken to be identical with the current which would exist on an infinite cylinder under the same excitation. This approximation is shown to be valid analytically and experimentally if the cylinder is not short. The analytic and experimental results are compared for 2 cylinder lengths. The turnstile antenna mounted on a finite cylinder is considered analytically, and the modification of the radiation by the cylinder is exhibited. In the case of the prolate spheroid excited by a narrow belt of electric field, experimental results are compared to analytic expressions. (Contractor's abstract)

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California Inst. of Tech. Antenna Lab., Pasadena.

SPATIAL DISTRIBUTION OF THERMAL RADIATION AT MICROWAVE FREQUENCIES, by N. George. June 1959, 138p. incl. illus. diagrs. tables, refs. (Technical rept. no. 18) (AFOSR-TN-59-592) (AF 18(600)1113) AD 217179 Unclassified

Theoretical and experimental radiation patterns are given in spectral form for the thermal radiation from thin slots or heated wires having dimensions of the order of the comparison wavelength. Maxwell's equations and noise theory from the basis of the analyses in which 3 independent methods are used to predict a spatial distribution which exhibits interference min and max. In the 1st method, the wave equation is solved for a noise-excited transmission which is suddenly short- and open-circuited at alternate ends. By a study of the trapped noise currents, it is found that radiation pattern has an interference structure which is smoothed as the loss is increased. Secondly, a formula is derived for the radiation pattern of a heated wire by a computation of its absorption in an isothermal enclosure and by an application of the principle of detailed balancing. Finally, the pattern of a long thin slot is computed directly using the Leontovich-Rytov distributed source generalization of Nyquist's noise formula. Fraunhofer pattern measurements are taken for a thin slot excited by a gaseous discharge at $10,100 \pm 200^\circ\text{K}$. The pattern measuring apparatus is a Dicke radiometer. (Contractor's abstract)

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[California Inst. of Tech. Antenna Lab. Pasadena].

TRANSIENTS ON A LINEAR ANTENNA, by G. G. Weill. Aug. 1959 [17]p. incl. diagrs. (Technical rept. no. 20) (AFOSR-TN-59-791) (AF 18(600)1113) AD 225003; PB 143158 Unclassified

Transmission is made on a lossless line of finite length with a wave front propagating with a velocity $\alpha = 1/\sqrt{LC}$ which reflects itself with a change in sign. The transmission line equations are given and the steady state obtained for $t = 2l/\alpha$. Diagrams are provided to illustrate directions of the field intensity.

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California Inst. of Tech. Antenna Lab., Pasadena.

RADIATION PATTERNS OF THE NOISE EMISSION FROM A GASEOUS DISCHARGE, by N. George [1959] 29p. incl. diagrs. refs. (Technical rept. no. 22) (AFOSR-TN-59-1101) (AF 18(600)1113) AD 229974; PB 145320 Unclassified

Theoretical and experimental radiation patterns are given in spectral form for the thermal radiation from a cylindrical discharge column which is adjacent to a long thin slot in a metallic plane. A spatial distribution is predicted which exhibits interference minima and maxima when the length of the slot and wavelength of the emission are the same order of magnitude. Fraunhofer pattern measurements are presented in which an Ar source is used to excite the slots of 7.3° and 9.5° radians in length. Data are also presented to show the effects of variations in the pressure and the dc current of the discharge. An interference phenomenon is predicted by the theory and demonstrated by an

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experiment, even though the source excitation is spatially distributed and essentially uncorrelated in time and in space. (Contractor's abstract)

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California Inst. of Tech. Antenna Lab., Pasadena.

A NOTE ON CURRENTS ON A QUADRATIC SURFACE, by G. G. Weill. [1959] 7p. incl. diagr. (Technical rept. no. 21) (AFOSR-TN-59-1102) (AF 18(600)1113) AD 229970; PB 145319 Unclassified

No explicit general solution is known for the vector integral equation satisfied by the current density vector on a conducting surface. The vector equation is shown to be scalarized in the case of a quadratic conducting surface. (Contractor's abstract)

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California Inst. of Tech. Antenna Lab., Pasadena.

CURRENT ON AN INFINITELY LONG CYLINDRICAL ANTENNA, by H. H. Kuehl. [1959] [9]p. incl. diagrs. (Technical rept. no. 23) (AFOSR-TN-59-1168) (AF 18(600)1113) AD 229794; PB 145315 Unclassified

The infinitely long circular cylindrical antenna driven at some cross section by a localized electromotive force, V , circumscribing the cylinder in a peripheral band is considered. The asymptotic expression for the current at large distances from the driving emf is derived using the saddle point method. It is shown that the amplitude of this current is proportional to the reciprocal of the logarithm of axial distance from the driving emf. (Contractor's abstract)

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California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

A NEW TRANSMITTING ANTENNA SYSTEM FOR VERY LOW RADIO FREQUENCIES, by W. Van Tuyl Rusch. June 26, 1959, 162p. incl. illus. diagrs. tables, refs. (Technical rept. no. 4) (AFOSR-TN-59-582) (AF 18(600)1552) AD 217029; PB 142988 Unclassified

A system is presented which employs resonant loading circuits to convert a section of an existing power line into a horizontal very-low-frequency transmitting antenna. The simplicity, low cost, and useful radiation pattern of this horizontal antenna are well suited for many experimental applications. The theoretical antenna problem was solved using a normal mode expansion of the current distribution. A matrix method was developed to compute the current distribution of a thin, linear antenna loaded with lumped-circuit elements, using a digital computer. The series was found to

converge relatively fast. Results were obtained for a full-wave linear antenna symmetrically loaded with real impedances Z_0 , one half-wavelength apart. Current distributions, feedpoint impedances, radiation patterns, etc., were presented as functions of Z_0 . Results of the idealized problem were applied to the powerline antenna. The matrix method can also be extended to the general linear antenna with any type of loading or feeding. System components, performance, and the 8.4 kc propagation experiments of the Dinkey Creek power-line antenna are described. The problem of interference with nearby audiofrequency communication systems is examined. The series of whistler-mode propagations to probe the exosphere was not completed. However, ionospheric soundings yielded considerable information about the properties of the ionosphere at very low frequency.

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California Inst. of Tech. Dept. of Electrical Engineering, Pasadena.

EXPERIMENTS IN VERY LOW-FREQUENCY RADIO PROPAGATION, by R. M. Golden. June 26, 1959, 124p. incl. illus. diagrs. refs. (Technical rept. no. 5) (AFOSR-TN-59-583) (AF 18(600)1552) AD 217030; PB 142987 Unclassified

In an effort to extend experimentally determined data on the characteristics of very-low-frequency radio waves, a VLF transmitting station (8.4 kc) was established at Shaver Lake, Calif. This station permitted controlled experiments in long distance propagation, ionospheric vertical sounding measurements, and attempts at the generation of round trip gyroelectric-echoes. The long distance measurements indicated that at VLF, the ground or surface wave radiated by the antenna can be detected at great distances. The ionospheric vertical incidence measurements showed rapid fading of the received signal around local sunrise and sunset. Propagation in the presence of the ionosphere is considered in the theoretical form of propagation in a homogeneous gyroelectric medium. An examination of the natural phenomena of whistlers is presented in order to determine the feasibility of generating gyroelectric-echoes. Reflection and transmission coefficients are presented for vertical incidence in order to ascertain the order of magnitude of such an echo.

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California Inst. of Tech. [Dept. of Electrical Engineering] Pasadena.

A NEW VERY LOW-FREQUENCY CW TRANSMITTER FOR IONOSPHERIC INVESTIGATION-KM2X1X, by R. M. Golden, R. V. Langmuir and others. [1959] [1]p. incl. diagr. (AF 18(600)1552) Unclassified

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Also published in Proc. Inst. Radio Engineers, v 47: 1381, Aug. 1959.

Announcement is made of preliminary results of a recently completed VLF transmitting station at Shaver Lake, Calif. An 8-mile section of a power line makes up the antenna. A strong signal can be detected at a distance of 250 km. Strong fading occurs in the late afternoon until sunset and at approximately sunrise.

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

[EXPANSION PROCEDURE AND SIMILARITY LAWS FOR TRANSONIC FLOW], by J. D. Cole. Final rept. Aug. 11, 1959 [2]p. (AFOSR-TR-59-118) (AF 18(600)-383) Unclassified

The results of work done under this contract are summarized. The most important of these are: (1) A better understanding of the physical basis of transonic flow, gained by a study of unsteady effects. (2) A reasonable mathematical basis for the derivation of the transonic approximation, achieved by a systematic use of expansion procedures. (3) Fundamental studies which led to a practical method of pressure distribution and drag estimation at $M_\infty = 1$.

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

MAGNETOHYDRODYNAMIC WAVES, by J. D. Cole. [1959] [20]p. incl. diagrs. (AF 18(600)383) Unclassified

Published in Proc. Third Symposium on Magnetohydrodynamics, Lockheed Research Lab., Palo Alto, Calif. (Nov. 21-22, 1958), Stanford, Stanford U. Press, 1959, p. 17-36.

This is a study of some special magnetohydrodynamic waves and their connection with the methods of their production, that is, the boundary conditions. Possible wave motions of a fluid form the underlying structure of the mathematical description. There is some evidence that these waves can be produced in the lab and may occur in nature. These waves occur in an ordinary gas dynamic fluid endowed with a scalar electrical conductivity. In practice, there is a fairly direct application to slightly ionized gases and conducting liquids. However, the general method of approach also applies to fully ionized plasmas described by continuum equations.

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

SMALL ASPECT RATIO MEMBRANE FLUTTER, by R. Stearman. Dec. 1958, 46p. Incl. illus, diagrs. tables, refs. (AFOSR-TN-59-45) (AF 49(638)220) AD 209416 Unclassified

An experimental investigation was undertaken on the flutter of small aspect ratio rectangular membranes in a subsonic flow. The leading and trailing edges of the membrane were restrained from vertical movement while the other two edges were free. Both surfaces of the membrane were exposed to the airstream, and the membrane tension was applied through the trailing edge. The results of the test show that two types of flutter occur. The first to appear as the wind speed was increased from zero, with a fixed tension level in the membrane, was a small amplitude flutter which had a shallow wave like motion travelling in the streamwise direction. At higher wind speeds this motion was damped out. A narrow equilibrium zone or boundary existed which separated the first type of flutter from a second type of motion having a traveling wave of larger amplitude and greater speed. This second type of flutter had no tendency to damp out, but became more violent as the wind speed was increased. The span of the slender membrane is the physical parameter that uniquely determines and controls the first flutter boundary; its mass plays no part here, but does affect the equilibrium zones. Appendix A contains an obvious formulation of the slender membrane flutter problem. (Contractor's abstract)

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

MAGNETOHYDRODYNAMIC WAVES, by J. D. Cole. Jan. 1959, 28p. Incl. diagrs. (AFOSR-TN-59-13) (AF 49(638)476) AD 208594; PB 140153 Unclassified

Special magnetohydrodynamic waves and the boundary conditions under which they are produced are studied. Possible wave motions of a fluid form the underlying structure of the mathematical description. The magnetohydrodynamic approximation used is the conventional one in that displacement currents are neglected. Shock waves in an infinitely conducting fluid are studied by means of an idealized piston problem. Switch-on waves are shown to be associated with the discharge of a current sheet. The effect of finite conductivity is studied for both ordinary and switch-on waves. Diffusion of current sheets about the wave front are shown. The effects of nonlinearity are discussed qualitatively.

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

A SHALLOW-LIQUID THEORY IN MAGNETOHYDRODYNAMICS, by L. E. Fraenkel. June 1959, 74p. incl. diagrs. refs. (AFOSR-TN-59-563) (AF 49(638)476) AD 216758; PB 145299 Unclassified

The nonlinear and linear shallow-water theories, which describe long gravity waves on the free surface of an inviscid liquid, are extended to the case of an electrically conducting liquid on a horizontal bottom, in the presence of a vertical magnetic field. The dish holding the liquid, and the medium outside it, are assumed to be non-conducting. The approximate equations are based on a small ratio of depth to wavelength, on the properties of mercury, and on a moderate magnetic field strength. These equations have a magneto-hydraulic character, for in the shallow liquid layer the horizontal fluid velocity and current density are independent of the vertical coordinate. Some explicit solutions of the linear equations are obtained for plane flows and for axis-symmetric flows in which the velocity vector lies in a vertical, meridional plane. (Contractor's abstract)

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

MAGNETOHYDRODYNAMIC SIMPLE WAVES, by J. D. Cole and Y. M. Lynn. Dec. 1959, 51p. incl. diagrs. table. (AFOSR-TN-59-1302) (AF 49(638)476) AD 234739; PB 148688 Unclassified

The simple wave solutions, which in ordinary gas dynamics correspond to expansion flows or Prandtl-Meyer flows are generalized here to ideal magnetohydrodynamic flows. The 1-dimensional unsteady (x, t) case is considered. Due to magnetic effects more than 1 component of field and velocity must be considered. To carry out the simple wave formalism the equations of motion (continuity, momentum, induction) are written in terms of flow velocities (u_1, u_2) . Alfvén velocities (b_1, b_2) and sound speed (a) . These velocities are then functions only of the phase $\xi = x_1 - U(\xi)t$; each phase line can be thought of as an infinitesimal wave propagating with a speed $c = U - u_1$ related to the flow. By elimination of (u_1, u_2) the system of 5 1st-order ordinary differential equations can be reduced to 3 (homogeneous) equations. The vanishing of the determinant of coefficients provides a famous relation for wave speed c and reduces the problem to integration of 2 1st-order equations. The further introduction of dimensionless variables, ratios of wave speeds, reduces the problem to integration of a single 1st-order equation. By studying the trajectories of this differential equation an

overall view of all possible solutions is obtained; numerical integration is also carried out in the case of slow waves. (Contractor's abstract)

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California Inst. of Tech. Guggenheim Aeronautical Lab., Pasadena.

MAGNETOHYDRODYNAMIC SIMPLE WAVES (SUPPLEMENT), by Y. M. Lynn. [May 1960] [25]p. (AFOSR-TN-59-1302, suppl.) (AF 49(638)476) PB 148929 Unclassified

As a supplement to a previous report (item no. 154, Vol. III) an exact analytic solution of the simple wave problem is presented, as well as some further computations of integral curves for fast waves. (Contractor's abstract)

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California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

PART I. EMISSION OF DIFFUSE BANDS OF SODIUM BEHIND SHOCK FRONTS, by H. Takeyama and A. Guttman. PART II. MOLECULE FORMATION IN INERT GASES, by A. Guttman. Aug. 1959, 20p. incl. illus. diagrs. tables, refs. (Technical rept. no. 10) (AF 18(603)2) AD 225671; PB 143522 Unclassified

Part I also published in Jour. Chem. Phys., v. 32: 634-635, Feb. 1960.

Part I. A diffuse emission band, centered near the resonance lines of sodium and attributed to van der Waals molecules Na_2 , has been observed in a shock tube. A small quantity of finely-ground sodium salt (e.g., NaCl , NaBr , or Na_2CO_3) was placed at the end of the low-pressure section of a shock tube containing an Ar atmosphere. Spectra were recorded photographically with a 1.5-m grating spectrograph. Part II. Microwave absorption spectra on inert gases (He, Ne, Ar, Kr, and Xe) or inert gas mixtures at low temperatures can probably be used to determine the interaction parameters required for the calculation of transport properties. This conclusion is reached from a study of predicted molecular spectra based on a determination of the Morse interaction potential through a 2nd-order fit to the known Lennard-Jones potential. (Contractor's abstract)

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California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

INTERACTION OF ELECTROMAGNETIC WAVES WITH IONIZED GASES, by R. G. John. Aug. 1959,

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44p. incl. diagrs. tables. (Technical rept. no. 9)
(AFOSR-TN-59-911) (AF 18(603)2) AD 226365;
PB 144221
Unclassified

Possibilities are explored with regard to the use of microwaves as probes to study ionized gas flows. The case is studied where the propagating waves are disturbed by the gas, rather than the gas being disturbed by the wave field. The distinction is mainly implicit in the strength of the impressed signal, and, to a certain extent, in the free charge and total particle densities. Waves of small amplitude are considered; therefore, no component of the gas other than the electrons, both free and bound, is significantly disturbed. As such, the treatment is relevant to such problems as the study of the characteristics of ionized gases by microwave probes, and the problems of electromagnetic communication into and through ionized gas layers. Throughout, the approach is one which starts from the basic field relations and at every opportunity takes the simplest alternatives consistent with physical experience, while attempting to demonstrate the salient features of the interaction with a minimum of mathematical encumbrance.

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California Inst. of Tech. Guggenheim Jet Propulsion Center, Pasadena.

THEORY OF THROUGHFLOW IN AXIAL TURBOMACHINES WITH VARIABLE WALL GEOMETRY, by G. C. Oates. Aug. 1959, 124p. incl. diagrs. refs. (Technical note no. 1) (AFOSR-TN-59-580) (AF 49(638)497)
Unclassified

The theory of 3-dimensional flow in axial turbomachines was extended to include the effects of variable hub and tip radii such as occur in the entrance stages of conventional axial flow compressors and, to a larger extent, in mixed flow compressors. The problem is simplified by assuming an infinite number of infinitely thin blades in each blade row, so that axially symmetric fluid motion results. The effect of variable hub and tip radii of the annulus walls is investigated when the tangential velocities are small but arbitrary, and when they are large but of special form. The combined effect of heavily loaded inlet guide vanes and variable hub radius is also investigated for the case in which the inlet guide vanes impart a motion very nearly of the solid-body type. The boundary conditions for the variable hub radius require linearization, thus restricting the magnitude of perturbation to be induced by the wall. Finally, the effect of a loaded blade row placed behind the inlet guide vane is determined. The local axial and tangential velocities induced by the variable wall radius were found to be of the same general magnitude as the velocities induced by a normal rotor or stator blade row. Although the forms of the solutions are somewhat complex for routine application in turbomachine design, a sufficiently simple approximate result is obtained for one case and it is indicated how the method of approximation may be extended. (Contractor's abstract)

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California Inst. of Tech. Palomar Observatory, Pasadena.

DIRECT RADIATIVE CAPTURE OF PROTONS BY O^{16} AND Ne^{20} , by N. Tanner. Dec. 1958 [5]p. incl. diagrs. table, refs. (AFOSR-TN-59-27) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)21], Atomic Energy Commission, and Office of Naval Research) AD 208870
Unclassified

Also published in Phys. Rev., v. 114: 1060-1064, May 15, 1959.

A study has been made of the $O^{16}(\rho, \gamma)Na^{21}$ reactions by counting the positron activities of F^{17} and Na^{21} following proton bombardment of oxygen and neon targets. The $O^{16}(\rho, \gamma)F^{17}$ cross section was measured at a proton bombarding energy of 616 kev to be 0.29 ± 0.03 microbarn and the $Ne^{20}(\rho, \gamma)Na^{21}$ cross section was measured at 1100 kev to be 1.3 ± 0.7 microbarns. These cross sections are consistent with the reaction process in each case being one of direct radiative capture. In addition, the energy dependence of the $O^{16}(\rho, \gamma)F^{17}$ cross section from 275 kev to 616 kev was also consistent with the direct-capture hypothesis. Both of these reactions are believed to be important at the thermal energies effective in stars. For such energies the cross-section parameter S_0 was estimated to be $S_0 = 5 \pm 1$ kev-barns for $O^{16}(\rho, \gamma)F^{17}$, and $S_0 \sim 80$ kev-barns for $Ne^{20}(\rho, \gamma)Na^{21}$. (Contractor's abstract)

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California Inst. of Tech. Palomar Observatory, Pasadena.

THE SPECTRUM OF THE IRREGULAR VARIABLE VY CANIS MAJORIS, by G. Wallerstein. [1958] [6]p. incl. tables. (AFOSR-TN-59-63) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) [AF 49(638)21] AD 234114
Unclassified

Also published in Astronom. Soc. Pacific, v. 70: 479-494, Oct. 1958.

VY Canis Majoris is a multiple star immersed in nebulosity. From the strength of the TiO bands in recent spectrograms the bright close pair is classed as M5. No emission lines were observed in the blue region, and H α was not present either in emission or absorption. In the yellow and red regions, however, the D lines of Na, the resonance lines of K at 7665 and 7699A, and the Ca line at 8573A were present in emission. This is believed to be the first star reported to show emission lines of K. The relative intensities of these emission lines indicate that the Na and Ca emissions do not originate in the same stellar regions. The temperature in the star atmosphere is estimated to be about 1000°K and the electron density between 10^9 and 10^{13} electrons/cm³.

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California Inst. of Tech. Palomar Observatory, Pasadena.

THE BRIGHTEST MAIN SEQUENCE STAR IN M 67, by G. Wallerstein. [1959] [4]p. incl. table, refs. (AFOSR-TN-59-658) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 234113
Unclassified

Presented at meeting of the Astronom. Soc. Pacific, San Francisco, Calif., June 1959.

Also published in Astronom. Soc. Pacific, v. 71: 451-454, Oct. 1959.

The brightest main sequence star in M 67 is a normal B8 star showing moderate rotation. Both its observed rotation, and its effective gravity as inferred from the equivalent width of $H\gamma$, point to the conclusion that the star has not reached its present position in the color-magnitude diagram by evolution from the turn-off point of the unevolved main sequence. Its origin is therefore completely unexplained. (Contractor's abstract)

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California Inst. of Tech. Palomar Observatory, Pasadena.

CONTINUUM COLORS OF THE SUN, ξ PEGASI, AND HD 19445 AS RELATED TO THE POSITION OF THE METAL-POOR STARS IN THE COLOR-MAGNITUDE AND TWO-COLOR DIAGRAMS, by E. M. Burbidge, G. R. Burbidge and others. [1959] [9]p. incl. tables, refs. (AFOSR-TN-59-860) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 240633
Unclassified

Also published in Mem. Soc. Roy. Sci. Liege, v. 3: 427-435, 1960.

The high-velocity, metal-poor, stars in general tend to lie $1 - 1\frac{1}{2}$ mag below the normal main sequence when they are plotted in a color-magnitude diagram (M_v vs $B - V$). Their spectral types, classified from low-dispersion spectra, also place them somewhat below the normal main sequence in the Hertzsprung-Russell diagram. Thus these stars have commonly been called "subdwarfs". In the present study, the metal-poor star HD 19445, ξ Peg, and the sun are compared in order to ascertain to what extent the ultra-violet excess of HD 19445 can be accounted for by the weakness of its metallic lines. From the results it was concluded that the name "subdwarfs" for the high-velocity metal-poor stars is a misnomer unless it is specified that they depart from the normal main sequence only in the color-magnitude plane. In the $\log T_e - M_{bol}$ plane and in the H-R diagram there is no measurable difference between the positions of these stars and the normal main

sequence. The ultra-violet excess of HD 19445, when plotted in a 2-color diagram, can be wholly accounted for by the effect of different line blanketing on the measured colors.

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California Inst. of Tech. Palomar Observatory, Pasadena.

THE ABUNDANCE OF LITHIUM IN T TAURI STARS AND RELATED OBJECTS, by W. K. Bonsack and J. L. Greenstein. [1959] [16]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-861) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 240634
Unclassified

Also published in Astrophys. Jour., v. 131: 83-98, Jan. 1960.

Spectrograms of 4 T Tauri stars involved in nebulosity and 8 stars possibly similar in some respects to T Tauri stars have been examined for the presence of the resonance doublet of Li I at λ 6708. A very strong feature at this wave length was found in the spectra of the 4 T Tauri stars and of SU Aur, which differs from Herbig's definition of the T Tauri class only in having a somewhat higher spectroscopic luminosity. Spectrophotometric analysis showed that the lithium/metals ratio in these 5 stars exceeds the solar ratio by a factor of 100 and approx equals the terrestrial value. No Li I was detected in the other 7 stars; except for the few hot stars included, these cannot then have lithium/metals ratios much in excess of the solar value. These results suggest that young stars have approx 1 lithium atom per 10^9 hydrogen atoms, at least in their atmospheres. Primary cosmic rays appear to be incapable of contaminating the interstellar medium, and then the entire protostar, with this amount of lithium. However, if a sufficiently efficient mechanism for the production of lithium at the surface of a star can be found, this result can be accomplished without the appearance of a large fraction of the star's energy as high-energy surface phenomena. The magnetic energy content of a protostar is sufficiently large that, if forced to the surface during the contraction and there dissipated in accelerating protons, the quantity of lithium required by the observations can be formed by spallation reactions in the atmosphere. (Contractor's abstract)

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California Inst. of Tech. Palomar Observatory, Pasadena.

ASTROPHYSICAL RESEARCH IN SPACE, by J. L. Greenstein. Sept. 21, 1959, 14p. (Special technical rept. no. 2) (AFOSR-TN-59-907) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 276328
Unclassified

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Also published in Fourth Ballistic Missile and Space Tech. Symposium, California U., Los Angeles (Aug. 24-27, 1959), New York, Pergamon Press, v. 1: 27-32, 1961.

Astronomers are seriously hampered in their studies by the atmosphere. Research from earth satellites can be carried on at heights such that most of these difficulties are overcome. A major portion of most astrophysical research can be carried out from large satellites at heights above 500 km. Upper atmosphere geophysics will be supplemented by astrophysics above the atmosphere. The problems of an orbiting telescope are discussed, but there seems little reason to go above 500 km. The earth's magnetic and electric fields, the ionosphere, the density, composition, and temperature of the atmosphere can be studied below this height. Low-resolution cloud mapping, the infrared albedo of the earth and other meteorological studies can be carried out at ordinary satellite heights. Higher altitudes, probably 1000 to 15,000 km, are needed for the study of upper air heating, the Van Allen belts, the cosmic ray albedo and the cosmic ray primaries. A discussion is presented regarding the height at which the earth and its influence are left and interplanetary space is entered.

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California Inst. of Tech. Palomar Observatory, Pasadena.

THE RADIAL VELOCITY OF SIGMA ORIONIS E, by G. Wallerstein. July 1959, 2p. incl. table. (AFOSR-TN-59-930) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 228276 Unclassified

Also published in *Astrophys. Jour.*, v. 130: 338-339, July 1959.

Observations were made of the star σ Orionis E with a 60-in. Cassegrain spectrograph and a 4-in. camera giving a dispersion of 80 Å/mm. Results of these observations are given. It is concluded that σ Orionis E differs from β Canis Majoris stars in 3 respects: (1) its lines are broadened by rapid rotation; (2) its absolute magnitude is lower; and (3) it has abnormally strong helium lines.

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California Inst. of Tech. Palomar Observatory, Pasadena.

ON A REVISED TABLE OF ABUNDANCES OF THE ELEMENTS BY A. G. W. Cameron, by G. R. Burbidge. [1959] 5p. (AFOSR-TN-59-1063) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 245962 Unclassified

Also published in *Astrophys. Jour.*, v. 131: 519-521, Mar. 1960.

An argument is presented that A. G. W. Cameron in a recent paper (*Astrophys. Jour.*, v. 129: 676-719, May 1959) assumes that observable results, when they disagree with theoretical expectations, can be adjusted to agree with the theory. It is pointed out that existing knowledge is, at this time, insufficient for this type of practice. It is indicated that Cameron has a very different model of the supernova process in which the r- and the p-process occur than that given in the fundamental abundance table. He also uses a different neutron source for the s-process. It is further pointed out that the use of theoretical expressions and smoothing of cross-sections is handled in a not usually accepted manner. Finally it is claimed that Cameron neglects the use of all astrophysical arguments in his presentation.

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California Inst. of Tech. Palomar Observatory, Pasadena.

ABUNDANCES IN SOME POPULATION II K GIANTS, by H. L. Helfer, G. Wallerstein, and J. L. Greenstein. [1959] [21]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-1064) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 228274 Unclassified

Also published in *Astrophys. Jour.*, v. 129: 700-719, May 1959.

Curve-of-growth analyses have been performed for 4 K giant stars, 2 in globular clusters, M13 and M92; a high-velocity star, HDE 232078; and a galactic cluster star (M41). The 3 population II stars show extreme metal deficiencies, the hydrogen/metal ratio being conservatively a factor of 20-100 times greater than in the solar case. The anomaly may be greater by still another factor of 10. The analysis of the galactic cluster star is more uncertain, but, within experimental error, it possesses the solar value of hydrogen/metals. Abundances of various elements relative to iron are derived. In all the stars, these are generally within a factor of 5 of the solar values. An examination of these abundances in the light of the recent compilation of nucleogenesis mechanisms by Burbidge, Burbidge, Fowler, and Hoyle (*Rev. Modern Phys.*, v. 29: 547-650, Oct. 1957) suggests that the e-process probably, and the s-process possibly, may need some modification. (Contractor's abstract)

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California Inst. of Tech. Palomar Observatory, Pasadena.

THE PERSISTENCE OF SPIRAL STRUCTURE, by K. H. Prendergast and G. R. Burbidge. [1960] [4]p. incl. table, refs. (AFOSR-TN-59-1066) (In cooperation with Yerkes Observatory, Williams Bay, Wis. and Mount Wilson Observatory, Pasadena, Calif.) (AF 49(638)21) AD 240635 Unclassified

Also published in *Astrophys. Jour.*, v. 131: 243-246, Jan. 1960.

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The assumption that individual spiral arms are long-lived features in a galaxy is disproved. It is shown that the form of the rotation-curves for spirals will insure that the spiral form will be completely distorted in a time short compared with the age of a galaxy. This is done by proving that 1 or more of the following assumptions cannot hold for certain cases and probably for all similar spiral galaxy cases. The assumptions are: (1) that material which is originally in a spiral arm remains in that arm, (2) that only circular velocities are present, and (3) that the circular velocity is independent of time.

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California Inst. of Tech. Palomar Observatory, Pasadena.

A REPLY TO G. R. BURBIDGE, by A. G. W. Cameron. [1959] 5p. (AFOSR-TN-59-1079) (In cooperation with Mount Wilson Observatory, Pasadena, Calif.) (AF 49-(638)21) AD 245962 Unclassified

Also published in *Astrophys. Jour.*, v. 131: 521-523, Mar. 1960.

In a reply to Burbidge's criticism (item no. 166, Vol. III) it is pointed out that the nuclear physical evidence on which the author places much weight is not inferior to "observational" evidence. It is explained that astronomical spectroscopy has not been as helpful as was hoped in telling the relative abundances of the elements. Thus, attention has been directed at bodies in which fractionation has obviously taken place, and the most useful of these is the chondrites although some elements have been lost or enriched in these materials. Under these circumstances, it is explained, the "observed" abundances in the chondrites need not be definitive numbers to which nuclear physics must be made to conform. The author's position on why he made certain modifications in the table of abundances is clarified. The different source of neutrons that reportedly has been used is further elaborated on and the uncertainty in neutron energy, which led the author to assign abundances on the basis of measured ratios, pointed out. The advantage of the revised abundance compilation is explained, and the fact that new data will probably necessitate further revisions in the table is stated.

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California U. Dept. of Chemistry, Berkeley.

MATRIX ISOLATION STUDIES: INFRARED SPECTRA OF INTERMEDIATE SPECIES IN THE PHOTOLYSIS OF HYDRAZOIC ACID, II, by M. Van Thiel and G. C. Pimentel. Feb. 25, 1959 [25]p. incl. diagrs. tables, refs. (AFOSR-TN-59-223) (AF 49(638)1) AD 211 805 Unclassified

Also published in *Jour. Chem. Phys.*, v. 32: 133-140, Jan. 1960.

Further infrared studies of the photolysis of hydrazoic acid in solid nitrogen at 20°K confirm the spectroscopic detection of unusual molecular species, as postulated earlier. The two most prominent bands, at 1325 and 1290 cm^{-1} , are shifted by a factor near $\sqrt{2}$ when DN3 is photolyzed. The data indicate the presence of either imine radical, NH_2 , or dimide, N_2H_2 . (Contractor's abstract)

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California U. Dept. of Chemistry, Berkeley.

FORMATION OF METHYL NITRITE IN THE PHOTOLYSIS OF GASEOUS NITROMETHANE, by G. C. Pimentel and G. Rollefson. Feb. 28, 1959 [12]p. incl. diagr. table. (AFOSR-TN-59-266) (AF 49(638)1) AD 212469 Unclassified

By infrared spectroscopic analysis methyl nitrite was found to be a product of photolysis of gaseous nitromethane. Its growth as a function of photolysis time shows that this product is itself photolyzed but that only a fraction of the decomposed parent molecules form methyl nitrite. The results are discussed in terms of the proposal that excited methyl nitrite is formed by recombination of CH_3 and NO_2 radicals formed in the primary photolytic process. These experiments cast light on the cage effect in the photolysis of nitromethane in solid Ar, as studied by Brown and Pimentel (*Jour. Chem. Phys.*, v. 29: 883-889, 1958). (Contractor's abstract)

172

California U. Dept. of Chemistry, Berkeley.

PERTURBATION OF MOLECULAR DISTRIBUTION FUNCTIONS BY CHEMICAL REACTION, by B. H. Mahan. [1959] [3]p. (AFOSR-TN-59-990) (AF 49(638)1) AD 227606; PB 144017 Unclassified

Also published in *Jour. Chem. Phys.*, v. 32: 362-364, Feb. 1960.

A collision cross section for radical combination reactions is derived which indicates that translationally hot free radicals combine faster than the average thermal radicals. The cross section is used to calculate the disturbance of the equilibrium distribution of velocities by radical combination reactions. It is concluded that the equilibrium assumption of chemical kinetics is justified for photochemical systems where the radical concentrations are low, but may be violated in systems where the free radical concentrations approach 0.1 mol fraction. (Contractor's abstract)

173

California U. Dept. of Chemistry, Berkeley.

SPECTROSCOPIC STUDY OF THE PHOTOLYSIS OF DIAZOMETHANE IN SOLID NITROGEN, by T. D. Goldfarb and G. C. Pimentel. [1959] [4]p. incl. diagr. refs. (AFOSR-TN-59-991) (AF 49(638)1) AD 227605; PB 144016 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 1865-1868, Mar. 5, 1960.

Further experiments are described in which diazomethane or partially deuterated diazomethane was suspended in solid nitrogen at 20°K and photolyzed with filtered light. Spectroscopic study extended from the ultraviolet (2300Å) through the infrared (to 420 cm^{-1}). An unstable substance is stored which produces ethylene after diffusion is permitted. This ethylene precursor is absent, as are visible-ultraviolet absorptions at 4182, 3968, and 3050-3300Å, when the photolyzing radiation includes only wave lengths longer than 3400Å. In contrast, the infrared absorptions observed earlier by Milligan and Pimentel are produced under these conditions, showing that the substance responsible is not the ethylene precursor. The data support the proposal that methylene is the precursor and suggest that some or all of the visible-ultraviolet absorptions are caused by methylene. Absorption at 2620Å was detected only in experiments at high concentration (low M/R), making it extremely unlikely that this absorption is caused by CH_2 . Finally, an absorption at 2470Å not caused by diazomethane was present before photolysis. This could be the tautomeric compound detected earlier by Müller and Ludsteck and called "isodiazomethane." (Contractor's abstract)

174

California U. Dept. of Chemistry, Berkeley.

INFRARED DETECTION OF THE FORMYL RADICAL HCO , by G. E. Ewing, W. E. Thompson, and G. C. Pimentel. [1959] [6]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1197) (AF 49(638)1) AD 228570; PB 144866 Unclassified

Also published in Jour. Chem. Phys., v. 32: 927-932, Mar. 1960.

The photolysis of HI, DI, HBr, and DBr suspended in solid CO at 20°K is described. The formyl radical, HCO or DCO , is produced, as shown by broad absorptions in the visible spectral region (6695, 6352, 6052, 5789, 5548, 5330, 5102Å) which correspond to absorptions of gaseous HCO . Infrared absorptions of HCO (at 1860 and 1031 cm^{-1}) and of DCO (at 1860 and 856 cm^{-1}) provide a basis for discussing the chemical bonding of this free radical and for calculating its thermodynamic properties. These experiments, the 1st infrared detection of a triatomic free radical by the

matrix isolation method, depend upon reactivity of the matrix, possibly eliminating difficulties of the cage effect. A correction in calculations is printed in Jour. Chem. Phys., v. 34: 1067, Mar. 1961. (Contractor's abstract)

175

California U. Dept. of Chemistry, Berkeley.

INFRARED SPECTRA OF H_2O , D_2O , AND HDO IN SOLID ARGON, KRYPTON, AND XENON, by E. Catalano and D. E. Milligan. [1959] [3]p. incl. diagrs. tables. (AF 49(638)1) Unclassified

Published in Jour. Chem. Phys., v. 30: 45-47, Jan. 1959.

Infrared spectra of H_2O and D_2O suspended in solid argon, xenon, and krypton have been obtained in the temperature range 20-4.2°K. A systematic study of the spectra of these species as a function of concentration and temperature has been carried out. Doublets with components centered within a few wave numbers of the gas phase OH and OD stretching frequencies are observed at dilutions in the range 500-1300 for the quantity M/R (M/R denotes molar ratio of rare gas to H_2O or D_2O). Spectra of these species in the bending region are considerably more complex. Between 3 and 8 bands with frequency separations on the order of $10\text{-}20\text{ cm}^{-1}$ are observed in this region. These features appear to be independent of M/R in the range 500-1300. At least one and possibly two of the lower frequency components in the spectrum H_2O in argon decrease in intensity on lowering the temperature of the sample. These results have been interpreted on the basis that H_2O and D_2O rotate in solid Ar, Xe, and Kr. (Contractor's abstract)

176

[California U. Dept. of Chemistry, Berkeley]

A MOLECULAR ORBITAL STUDY OF IONIZATION POTENTIALS OF ORGANIC COMPOUNDS. I. RADICALS AND NON-ALTERNANT HYDROCARBONS. II. METHYL COMPOUNDS. III. SATURATED HYDROCARBONS. IV. ACETYLENES AND ALLENES. V. CHLORINE, OXYGEN AND NITROGEN COMPOUNDS, by A. Streitwieser, Jr. [1959] 1v. incl. tables, refs. (AFOSR-TN-59-893) (AF 49(638)105) AD 243130; PB 144168 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 4123-4135, Aug. 20, 1960. (Title varies)

The ω -technique in the simple lcao theory is applied to a variety of organic compounds. A comparison of the

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method with Pople's self method shows that the use of the ω -parameter provides for electron repulsion effects in an empirical manner. Such a procedure is required when dealing with cations; for example, in the simple lcao theory the ionization potentials of methyl, allyl and benzyl radicals should be identical. The experimental values which vary over a 2 ev range are well reproduced by the ω -technique. The method is applied to several organic radicals of current interest, including cyclopentadienyl and tropylium. Agreement with experimental results, where available, is excellent. With aromatic hydrocarbons, however, including examples of the non-alternant hydrocarbon type, the simple lcao procedure gives a good correlation of ionization potentials; the ω -technique provides no advantage with such systems alone. Heteroatoms can be treated given 2 additional parameters characteristic of the heteroatom. A methyl group is treated as a pseudo-heteroatom donating 2 electrons to the π -system with parameter values differing slightly from those previously employed. Good agreement between calculated and experimental ionization potentials was obtained for a large number of methyl substituted hydrocarbons and radicals. Experimental potentials were used for chlorine, nitrogen and oxygen compounds to determine empirically the appropriate parameter values for those elements. The derived values are compared with those used previously in other applications in the literature. The ω -technique is extended to calculations of acetylenic and allenic systems. A simple model of an alkane is presented which requires only 1 additional disposable parameter. The derived value of 0 for this parameter is used with the ω -technique to give good agreement between calculated and experimental ionization potentials for a variety of alkanes. (Contractor's abstract)

177

[California U. Dept. of Chemistry, Berkeley]

SIMPLE MOLECULAR ORBITAL CALCULATIONS.
[1959] 1v. incl. tables. (AFOSR-TN-59-893a; appendices A-D) [AF 49(638)105] AD 243577 Unclassified

Using an IBM 701 high-speed digital computer, molecular orbital calculations have been made for many of the compounds discussed in item no. 176. The data include eigenvalues and eigenvectors of the occupied orbitals, electron densities, and bond orders. The presentation of the data is interpreted in appendix A.

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California U. Dept. of Mathematics, Berkeley.

A CHARACTERIZATION OF INVARIANT AFFINE CONNECTIONS, by B. Kostant. Mar. 1959, 2 pp. (Technical rept. no. 10) (AFOSR-TN-59-208) (AF 49-638)79 AD 211662; PB 140426 Unclassified

Also published in Nagoya Math. Jour., v. 10: 35-50, Feb. 1960.

The following theorem is proved: Let A be an affine connection on a simply connected manifold M. Then M is a reductive homogeneous space with respect to a connected Lie group G whose action leaves A invariant if and only if there exists an affine connection B on M

such that (1) R^A and T^A are covariant constant with respect to B, (2) A is rigid with respect to B, and (3) M is complete with respect to B. R and T are the torsion and curvature tensor fields on M, respectively.

179

California U. Dept. of Mathematics, Berkeley.

A NOTE ON CERTAIN POLYNOMIAL ALGEBRAS, by E. Thomas. Jan. 1960, 9p. (Technical rept. no. 12) (AFOSR-TN-59-937) (AF 49(638)79) AD 233363; PB 145556 Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 410-414, June 1960.

This note considers polynomial algebras defined over integral domains of characteristic 2. For each algebra a derivation β is defined, and the main theorem gives a splitting of the algebra relative to β . The theorem is then applied to several examples from Algebraic Topology: (1) the mod. 2 cohomology algebras of the Grassmann complexes, and (2) the subalgebra W of a Thom algebra N of non-oriented differentiable manifolds. (Contractor's abstract)

180

California U. Dept. of Mathematics, Berkeley.

WHICH LIE GROUPS ARE HOMOTOPY-ABELIAN?, by I. James and E. Thomas. Sept. 1959, pp. incl. refs. (Technical rept. no. 11) (AFOSR-TN-59-982) (AF 49-638)79 AD 226764; PB 144369 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 737-740, May 1959.

A topological group G is homotopy-abelian if the mappings f and \bar{f} , of $G \times G$ to G , are homotopic, where $f(x, y) = xy = f(y, x)$ ($x, y \in G$). The problem considered in this paper is whether any of the non-abelian Lie groups are homotopy-abelian. The main result is: Theorem: The classical structure classes contain no Lie group which is homotopy-abelian but not abelian. The method used is a generalization of that used by H. Samelson to show that $Sp(1)$ is not homotopy-abelian. (Contractor's abstract)

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California U. Dept. of Mathematics, Berkeley.

BOUNDS FOR THE FIRST EIGENVALUE OF A

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RHOMBIC MEMBRANE, by W. Hooker and M. H. Protter. Apr. 1959, 29p. incl. diagrs. tables. (Technical rept. no. 3) (AFOSR-TN-59-128) (AF 49(638)-398) AD 210616; PB 142374 Unclassified

Also published in Jour. Math. and Phys., v. 39: 18-34, Apr. 1960.

A new method for finding lower bounds for the first eigenvalue of elliptic equations is applied to the case of a rhombus. It is shown that a simple analytic expression can be obtained which is a superior lower bound to those obtained by symmetrization. Some refined upper bounds are obtained so that the exact value is confined to a narrow range for all angle openings. These results are useful in the application of the inclusion principle for lower bounds of arbitrary domains. (Contractor's abstract)

182

California U. Dept. of Mathematics, Berkeley.

UNIQUENESS THEOREMS FOR EQUATIONS OF MIXED TYPE III, by M. H. Protter. Mar. 1959, 15p. incl. refs. (Technical rept. no. 4) (AFOSR-TN-59-234) (AF 49(638)398) AD 212004; PB 142364 Unclassified

Uniqueness theorems for equations of the form $K(y)u_{xx} + u_{yy} = 0$ are established when it is assumed that u vanishes on a simple arc in the elliptic portion of the domain and on either a characteristic or non-characteristic arc in the hyperbolic region. The restrictions on the domain that were required in the uniqueness proofs of earlier works are eliminated. (Contractor's abstract)

183

California U. Dept. of Mathematics, Berkeley.

VIBRATION OF A NONHOMOGENEOUS MEMBRANE, by M. H. Protter. Apr. 1959, 11p. (Technical rept. no. 5) (AFOSR-TN-59-279) (AF 49(638)398) AD 212912 Unclassified

Also published in Pacific Jour. Math., v. 9: 1249-1255, 1959.

A comparison theorem is established for the 1st eigenvalue of homogeneous and nonhomogeneous membranes of the same shape. The 1st eigenvalues λ_0 and λ_1 are considered for the equations $u_{xx} + u_{yy} + \lambda p(x,y)u = 0$ and $v_{xx} + v_{yy} + \lambda v = 0$, respectively, in the same domain D subject to the boundary conditions $u = 0$ and $v = 0$ on Γ , respectively. Also compared are the eigenvalues of 2 different nonhomogeneous membranes of the same shape.

184

California U. Dept. of Mathematics, Berkeley.

ON DIFFERENCE METHODS FOR THE SOLUTION OF A PARTIAL DIFFERENTIAL EQUATION OF MIXED TYPE, by H. Ogawa. Mar. 1959, 22p. incl. diagrs. (Technical rept. no. 6) (AFOSR-TN-59-280) (AF 49(638)398) AD 212913; PB 142365 Unclassified

A boundary value problem for the mixed partial differential equation $K(y)u_{xx} + u_{yy} = f(x,y)$, with $K > 0$ for $y > 0$, $K < 0$ for $y < 0$ and $K(0) = 0$, is approximated by a boundary value problem for a difference equation, which is shown to have a solution under certain conditions on the function K . The solution of the difference equation is then shown to converge to the solution of the differential equation, provided the latter exists and is sufficiently smooth. The present work is a generalization of the methods used by Filippov in considering the equation with $K(y) = y$. These methods depend essentially on proving that the solution of the difference equation satisfies a maximum principle analogous to the maximum principle for the differential equation. (Contractor's abstract, modified)

185

California U. Dept. of Mathematics, Berkeley.

UNIQUE CONTINUATION FOR ELLIPTIC EQUATIONS, by M. H. Protter. May 1959, 18p. incl. refs. (Technical rept. no. 7) (AFOSR-TN-59-476) (AF 49(638)398) AD 215719 Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 81-91, Apr. 1960.

A proof is given for a unique continuation theorem for linear 2nd-order elliptic equations. This is somewhat simpler than the previous proofs of Aronszajn, Cordes and Pedersen as no considerations of differential geometry are required. In addition the method of proof extends easily to higher order equations in which the highest derivative form is the iterated Laplacian. (Contractor's abstract)

186

California U. Dept. of Physics, Berkeley.

MICROWAVE FARADAY ROTATION: MEASUREMENT OF THE CONDUCTIVITY TENSOR, by A. M. Portis. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, National Security Agency, Office of Naval Research under [Nonr-22201], and Signal Corps) Unclassified

Presented at 1958 Internat'l. Conf. on Semiconductors, Rochester U., N. Y., Aug. 18-22, 1958.

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Published in Jour. Phys. and Chem. Solids, v. 8: 326-329, Jan. 1959.

The application of microwave Faraday rotation to the measurement of magnetoconductivity is discussed. Interest is directed to the currents flowing transverse to the magnetic field. It is pointed out that the results of the microwave measurements may be directly related to the elements of the conductivity tensor. A number of effects which must be considered on comparing low frequency and microwave measurements are listed including surface charge effects, non-ohmic contacts' effects, and those of shunt capacity.

187

California U. Dept. of Physics, Berkeley.

ON THE TEMPERATURE DEPENDENCE OF ANISOTROPY ENERGY IN ANTIFERROMAGNETS, by P. Pincus. [1959] 8p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)46, National Security Agency, Office of Naval Research, and Signal Corps) Unclassified

Published in Phys. Rev., v. 113: 769-770, Feb. 1, 1959.

The Akulov-Zener classical theory of the temperature dependence of ferromagnetic anisotropy energy is extended to the antiferromagnetic case. The result, for short range interactions only, is that

$$K_n(T)/K_n(0) = [M(T)/M(0)]^{n(n+1)/2},$$

where $K_n(T)$ is the n th order anisotropy constant and $M(T)$ is the sublattice magnetization. Here, $K_n(0)$ and $M(0)$ refer to the corresponding quantities at absolute zero. The result is verified by a spin calculation. (Contractor's abstract)

188

California U. Dept. of Physics, Berkeley.

METALLIC TRANSITION IN LITHIUM HYDRIDE, by R. E. Behringer. [1959] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46], National Security Agency, Office of Naval Research, and Signal Corps) Unclassified

Published in Phys. Rev., v. 113: 787-792, Feb. 1, 1959.

The dependence on lattice parameter, or pressure, of the energy gap between the last filled and first empty energy band in LiH is investigated. The crystalline potential is approximated by a Wigner-Seitz atomic-spheres potential, corrected to account for the effects of overlapping spheres, and the wave functions are expanded in symmetrized plane waves. In addition the

effect of varying the relative size of the lithium and hydrogen ion spheres is considered. The energy levels at the top of the filled band and the bottom of the empty band are determined at several values of the lattice parameter, using 6, 7, 8, 9, and 10 symmetrized plane waves. The problem of convergence is examined. The model predicts that transition to the metallic state should occur at a pressure of about 35 megabars. The results are discussed in light of recent experimental investigations. (Contractor's abstract)

189

California U. Dept. of Physics, Berkeley.

THEORY OF NUCLEAR QUADRUPOLE INTERACTION IN BERYLLIUM METAL, by M. Pomerantz and T. P. Das. [1959] [9]p. incl. diagrs. refs. (In cooperation with Illinois U., Urbana AF 18(600)689) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)46] and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 251, Apr. 30, 1959. (Title varies)

Published in Phys. Rev., v. 119: 70-78, July 1, 1960.

The theory of the origin of the field gradient at nuclei in metals has been analyzed. The contributions of the ion cores and conduction electrons have been separately considered. In the case of beryllium metal, using orthogonalized plane wave functions, the conduction electrons are shown to enhance, by about 8%, the field gradient due to the ion cores. Combining the results of our calculations with Knight's experimental value of 46 kc/sec for the Be⁹ coupling constant $e^2 q Q / h$, a value of $Q = 0.032 \times 10^{-24} \text{ cm}^2$ is obtained. The dependence of the potential for the conduction electrons on the mode chosen is analyzed in some detail. The various uncertainties in our field-gradient calculation and the theoretical value of the Knight shift in beryllium metal are discussed. (Contractor's abstract)

190

California U. Dept. of Physics, Berkeley.

INELASTIC FINAL-STATE INTERACTIONS: K⁻ ABSORPTION IN DEUTERIUM, by R. Karplus and L. S. Rodberg. [1959] [53]p. incl. diagrs. tables, refs. (AFOSR-TN-59-332) (AF 49(638)327) AD 213653; PB 142409 Unclassified

Also published in Phys. Rev., v. 115: 1058-1069, Aug. 15, 1959.

In a reaction from which several strongly interacting

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particles emerge, it is often possible to isolate the effects of forces between two of the outgoing particles. There are many cases in which this final-state interaction can produce inelastic reactions. The formalism that describes this situation is developed, and the reaction $K^- + D \rightarrow \pi + \Sigma + N \rightarrow \pi + \Lambda + N$ is studied in detail as an example. It is found that large Λ/Σ branching ratios can result and can be used to restrict the Σ -N and K-N interaction parameters. The gross features of the spectrum can be understood using a simple model. It does not seem possible to determine the parities of the strange particles from the momentum spectra. When the inelastic reaction in the final state is exothermic, as in the example, high partial waves may contribute. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

ANALYTIC PROPERTIES OF TRANSITION AMPLITUDES IN PERTURBATION THEORY, by S. Mandelstam. [1959] [38]p. incl. diagrs. refs. (AFOSR-TN-59-436) (AF 49(638)327) AD 214798; PB 142146
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 50, Jan. 28, 1959. (Title varies)

Also published in Phys. Rev., v. 115: 1741-1751, Sept. 15, 1959.

The analytic properties of 2-particle transition amplitudes as functions of both energy and momentum transfer are examined in perturbation theory. The modified Nambu representation previously proposed by the author for expressing these properties is discussed in a little more detail. It is shown that, as long as the masses do not satisfy certain inequalities connected with the existence of anomalous thresholds, the fourth-order terms, calculated in the usual manner, satisfy the representation. The spectral functions are calculated explicitly for spinless particles. The proof can be extended to the sixth order, but is not worked out here. The modifications necessary when there exist anomalous thresholds are mentioned.

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California U. Dept. of Physics, Berkeley.

CONSTRUCTION OF THE PERTURBATION SERIES FOR TRANSITION AMPLITUDES FROM THEIR ANALYTICITY AND UNITARITY PROPERTIES, by S. Mandelstam. [1959] [42]p. incl. diagrs. refs. (AFOSR-TN-59-437) (AF 49(638)327) AD 214799; PB 142145
Unclassified

Also published in Phys. Rev., v. 115: 1752-1762, Sept. 15, 1959.

The analyticity properties of transition amplitudes are used in conjunction with the unitarity requirements to generate successive terms in the perturbation series, without referring to a specific Lagrangian. In the sixth and higher orders, production is neglected in the unitarity condition; subject to this approximation, it is found that the series can be so constructed. No analyticity properties which have not been rigorously proved need be employed, and the terms are found to satisfy the double dispersion representation. By examining the connection between this method and the conventional calculation of the perturbation series the types of spectral function corresponding to different Feynman diagrams can be found. Formulae are given for the regions in which the spectral functions are non-zero. (Contractor's abstract)

193

California U. Dept. of Physics, Berkeley.

THEORY OF THE LOW-ENERGY PION-PION INTERACTION, by G. F. Chew and S. Mandelstam. Apr. 15, 1959 [43]p. incl. diagrs. (Rept. no. UCRL-8728) (AFOSR-TN-59-520) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)327 and Atomic Energy Commission) AD 216251
Unclassified

Also published in Phys. Rev., v. 119: 467-477, July 1, 1960.

The double-dispersion representation is applied to the problem of pion-pion scattering, and it is shown that, if inelastic effects are important only at very high energies, a set of integral equations for the low-energy amplitudes can be derived. The solution of these equations appears to depend on only one arbitrary real parameter, which may be defined as the pion-pion coupling constant. The order of magnitude of the new constant is established, and a procedure for solving the integral equations by iteration is outlined. (Contractor's abstract)

194

California U. Dept. of Physics, Berkeley.

ONE PARTICLE SINGULARITIES OF GREEN FUNCTIONS IN QUANTUM FIELD THEORY, by W. Zimmermann. [1959] [19]p. incl. refs. (AFOSR-TN-59-568) (AF 49(638)327) AD 217002; AD 226911
Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 503-521, Aug. 1959.

The general structure is investigated of the vacuum and the 1-particle singularities of the τ -functions, in

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the case that all variables p_i are real 4 vectors. In the case of forward scattering, the Fourier transform is applied to dispersion relations in order to determine the indefinite constant appearing in Bogoljubov's treatment of the 1-particle singularities. The result thus obtained is in agreement to Symanzik's form of the 1-particle term in the dispersion relation for forward scattering.

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California U. Dept. of Physics, Berkeley.

NOTE ON THE K-MESON NUCLEON INTERACTION, by R. Karplus, L. Kerth, and T. Kycia. [1959] [9]p. incl. tables, refs. (AFOSR-TN-59-677) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)327 and Atomic Energy Commission) AD 225767; PB 145577 Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 510-513, June 15, 1959.

The K-nucleon-hyperon coupling terms are examined using the dispersion relation formalism. Two parameters are defined: $p_A(p_\Sigma)$ describing the $K^- \Lambda(K^- \Sigma)$ -nucleon relative parity, and $X_A(X_\Sigma)$ which is proportional to the $K^- \Lambda N(K^- \Sigma N)$ coupling constant $g^2 \Lambda(g^1 \Sigma)$. The calculation of an "average" coupling $\langle pX \rangle_{Av}$ at an "average" pole $\omega[\omega = 1/2(\omega_A + \omega_\Sigma)]$ where ω is the K-meson laboratory energy and $X_A(X_\Sigma)$ is the magnitude of the residue evaluated at $\omega = \omega_A(\omega_\Sigma)$ leads to the conclusion that the K^+ -proton interaction calculated by this method is insufficiently sensitive to the coupling parameters to permit their evaluation from present data. A consideration of the real part of the K^- -proton forward scattering amplitude suggests that the K^- -proton force is attractive.

196

California U. Dept. of Physics, Berkeley.

SPECTRAL REPRESENTATIONS IN PERTURBATION THEORY. III. THE SCATTERING AMPLITUDE WITH TWO COMPLEX INVARIANTS, by J. Tarski. [1959] 45p. incl. diagrs. refs. (AFOSR-TN-59-1071) (AF 49(638)327) AD 229981; PB 145322 Unclassified

Also published in Jour. Math. Phys., v. 1: 149-164, Mar.-Apr. 1960. (Title varies)

The partial Feynman amplitude corresponding to a particular 4th order diagram is examined as a function of energy and momentum transfer with both of these variables complex. The region of regularity of this function is found, and the types of singularities at the

remaining points are determined. An approach which requires only elementary calculations is developed. The condition for the validity of Mandelstam's representation in the 4th order is obtained. Spectral representations for exchange scattering processes at fixed momentum transfer are discussed as another application of the principal results. (Contractor's abstract)

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California U. [Dept. of Physics] Berkeley.

UNIQUENESS OF RADIATIVE SOLUTIONS TO THE SCHRÖDINGER WAVE EQUATION, by C. Zemach and F. Odeh. [1959] 23p. (AFOSR-TN-59-1112) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)327 and Office of Naval Research under Nonr-22260) AD 243991 Unclassified

Also published in Arch. Rational Mech. and Anal., v. 5: 226-237, 1960.

A report is presented on the uniqueness question for the exterior Dirichlet, or Neumann problem associated with the Schrödinger wave equation with a suitably restricted real potential $V(r)$: $[\nabla^2 + k^2 - V(r)] \psi(r) = 0$. The main results of this research are: (1) under suitable restrictions (less strict than Miranker's) on V , there does exist a uniqueness theorem for the problem at hand. (2) The radiation condition implies the boundedness condition: $\psi(r) = O(r^{-1})$ for the solution considered. (3) These considerations fail when $k = 0$, and a counterexample is given in this case.

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California U. Dept. of Physics, Berkeley.

ELECTROMAGNETIC STRUCTURE OF THE NUCLEON, by A. M. Bincer. Nov. 1959, 34p. incl. refs. (AFOSR-TN-59-1217) (AF 49(638)327) AD 229978; PB 145041 Unclassified

Also published in Phys. Rev., v. 118: 855-863, May 1, 1960.

Dispersion relations are proved for the electromagnetic and mesonic nucleon vertex functions considered as a function of the nucleon mass. The results are used to express the isotopic scalar and the isotopic vector electromagnetic form factors of the nucleon in terms of pion electroproduction (or photoproduction) and pion-nucleon scattering amplitudes in the $J = \frac{1}{2}$, $T = \frac{1}{2}$ state. (Contractor's abstract)

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California U. [Dept. of Physics] Berkeley.

RaE AND THE SHELL MODEL (Abstract), by A.

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Bincer, E. Church, and J. Weneser. [1959] [1]p.
(Sponsored jointly by Air Force Office of Scientific
Research under [AF 49(638)327] and Atomic Energy
Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New
York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
59, Jan. 28, 1959.

In an extension of previous work, an attempt has been
made to correlate the spectral shape, longitudinal po-
larization, and lifetime of the beta decay of $\text{RaE}(\text{Bi}^{210})$
in terms of jj coupling model with configuration mixing.
The configurations considered important in the initial
(1-) state are: $(h_{9/2})p^1 (g_{9/2})n^1$, $(h_{9/2})p^1 (g_{7/2})n^1$,
 $(h_{9/2})p^1 (i_{11/2})n^1$, and $(h_{11/2})p^{-1} (h_{9/2})p^2 (g_{9/2})n^1$.

The final (0+) state is taken as $(h_{9/2})p^2$ plus the doubly
magic Pb^{208} core. Other admixed configurations would
not contribute importantly to the beta-decay matrix ele-
ments. The immediate objective is the use of the ex-
perimental data to fix the mixture of configurations,
with the usual assumptions of a 2-component neutrino
theory with VA interactions invariant under time re-
versal. It has been found that the choices of nuclear
configurations which best fit the shape and lifetime
yield a longitudinal polarization of $\sim -(85-90\%)v/c$.

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California U. [Dept. of Physics] Berkeley.

SEARCH FOR LEPTONIC DECAY MODES OF THE
SIGMA, by J. Leitner, P. Nordin, Jr. and others.
[1959] [3]p. incl. diagrs. table. (Sponsored jointly by
Air Force Office of Scientific Research under [AF 49-
(638)327] and Atomic Energy Commission) Unclassified

Published in Phys. Rev. Ltrs., v. 3: 186-188, Aug. 15,
1959.

Presented at meeting of the Amer. Phys. Soc.,
Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract also published in Bull. Amer. Phys. Soc.,
Series II, v. 4: 356, Aug. 27, 1959. (Title varies)

As part of a continuing study of K^- absorption in
hydrogen, an attempt has been made to obtain evidence
of Σ leptonic decay modes. The selected sample con-
sisted of only well-measured events—750 Σ^- and
250 $\Sigma^+ \rightarrow \pi^+ + n$ (effectively 500 Σ^+). The search was
carried out by studying the (lab) momentum distribution
of the Σ -decay products. The observed distribution was
roughly Gaussian, centered about 190 mev/c, the value
expected for $\Sigma^\pm \rightarrow \pi^\pm + n$. A detection cutoff was

chosen at 100 mev/c, just below the tail of the spectrum
due to small-angle single Coulomb scattering; 45% of
the leptonic phase-space spectrum falls below 100 mev/c.
No decays have been found below 115 mev/c among
(0.45 x 750 =) 335 effective Σ^- and 225 effective Σ^+ , so
that the upper limits of leptonic branching fractions are

$$f(\Sigma^- \rightarrow \mu^- + \nu + n) \leq 0.3\%,$$

$$f(\Sigma^+ \rightarrow \mu^+ + \nu + n) \leq 0.45\%.$$

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California U. [Dept. of Physics] Berkeley.

ON THE BEHAVIOR OF THE SCATTERING PHASE
SHIFT IN THE PRESENCE OF INELASTIC PROCESSES
(Abstract), by M. A. Ruderman and C. M. Sommerfield.
[1959] [1]p. (Sponsored jointly by Air Force Office of
Scientific Research under [AF 49(638)327] and
National Science Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
375, Aug. 27, 1959.

Under consideration are processes involving inelastic
scattering which may be described in terms of a non-
local, energy-dependent, complex potential. It is
found, with suitable restrictions, that a potential which
describes the propagation of fields with a speed less
than that of light yields a complex scattering phase shift
whose real part decreases by $(n_b - n_f)\pi$ as the energy
increases from threshold to infinity. Here n_b is the
number of bound states produced by the potential and
 n_f is the number of elementary fields in the process.
To the extent that such potentials provide adequate
descriptions of the interactions, experimental deter-
mination of the energy behavior of the scattering phase
shifts will allow a distinction to be made between those
fields to be taken as elementary and those to be con-
sidered as composite.

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California U. [Dept. of Physics] Berkeley.

ANALYTIC PROPERTIES OF THE AMPLITUDE FOR
THE SCATTERING OF A PARTICLE BY A CENTRAL
POTENTIAL, by A. Klein and C. Zemach. [1959] [16]p.
incl. refs. (Sponsored jointly by [Air Force Office of
Scientific Research under AF 49(638)327], Atomic
Energy Commission, and National Science Foundation)
Unclassified

Published in Ann. Phys., v. 7: 440-455, Aug. 1959.

A new proof is given that the scattering amplitude

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considered as a function of energy, for fixed momentum transfer, has those analytic properties in the energy variable which imply a dispersion relation. The proof is based on the known behavior of the Green's function, as the resolvent of a self-adjoint transformation, and on the study of the Born series. The class of potentials considered is the same as in previous studies. It is shown that for potentials of arbitrary strength the Born series converges uniformly to its first term for sufficiently high energies, real or complex. The analytic properties of the scattering amplitude as a function of momentum transfer for fixed real energy are also investigated and used to establish the domain of convergence of partial wave and related expansions. In particular the use of such expansions to define the amplitude in the unphysical region which occurs in the dispersion relation is fully justified for the same domain of momentum transfer for which the relation itself is valid, i.e.: $\Delta < 2\alpha$, where Δ is the momentum transfer and α^{-1} the range of the potential. All proofs apply equally to the Schroedinger and to the Klein-Gordon equations. (Contractor's abstract)

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California U. [Dept. of Physics] Berkeley.

SIGMA SPIN AND PARITY CONSERVATION IN $K^- + p \rightarrow \Sigma^+ + \pi^-$, by J. Leitner, P. Nordon, Jr. and others. [1959] [2]p. incl. diag's. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49-638)327] and Atomic Energy Commission)

Unclassified

Published in Phys. Rev. Ltrs., v. 3: 238-239, Sept. 1, 1959.

A report is made of the finding of very strong evidence of a spin-1/2 sigma on the basis of an analysis of 145 Σ^+ hyperons produced in K^- absorption when K^- mesons come to rest in liquid hydrogen. A check on the hypothesis of parity conservation in the reaction $K^- + p \rightarrow \Sigma^+ + \pi^-$ is also reported. It is stated that if the assumption is that the K meson has zero spin and is captured from an s state, then the maximum component of angular momentum that the Σ can have along its direction of flight is 1/2. Furthermore, if the Σ has a spin greater than 1/2, this leads to an alignment of its spin, J, perpendicular to its direction of motion. This and other supporting evidence leads to the opinion that the s-state capture is well grounded. Assuming this, the folded distributions $f_J(|\cos \theta|)$ become $f_{1/2} = 1$, $f_{3/2} = 1/2(1 + 3 \cos^2 \theta)$ and analyzing the data in terms of the normalized function $f_{\frac{1}{2}} F(|\cos \theta|) = 1/2(1 + A \cos^2 \theta) (1 + A/B)^{-1}$ constitutes the strongest evidence to date that sigma spin is 1/2. Search is also made for parity nonconservation in the reaction $K^- + p \rightarrow \Sigma^+ + \pi^-$ and for parity violation. No evidence for parity nonconservation in Σ^+ production is found.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF Br^{77} (Abstract), by T. M. Green, H. [L.] Garvin and others. [1959] [1]p. Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 250, Apr. 30, 1959.

The nuclear spin of 57-hr Br^{77} has been measured by the method of atomic beams. The isotope is produced by an $(\alpha, 2n)$ reaction using the 38-mev beam from the Berkeley 60-in. cyclotron. Bromine atoms are formed in a quartz rf discharge tube and detected by their radioactive decay, after collection on silver-coated buttons. For Br^{77} the spin is found to be 3/2, and because $I = J = 3/2$ both flop-in transitions occur at the same frequency, at low magnetic fields. The resonance has been observed at 5 different magnetic fields up to 48 gauss. A spin of 3/2 is expected from the previously observed spins of 3/2 for Br^{79} and Br^{81} , which differ from Br^{77} by 1 and 2 pairs of neutrons, respectively. Work is being continued to obtain values of the hyperfine-structure separations, magnetic moment, and electric quadrupole moment of this isotope.

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California U. [Dept. of Physics] Berkeley.

SUMMARY OF SOME NUCLEAR SPIN, MOMENTS, AND HYPERFINE STRUCTURE MEASUREMENTS, by H. A. Shugart. [1959] [3]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)339, Atomic Energy Commission, and Office of Naval Research)

Unclassified

Also published in Fourth Brookhaven Conf. on Molecular Beams, Heidelberg U. (Germany), June 9-11, 1959, p. 5(1-3). (AFOSR-TR-59-152, AD 228005)

A number of radioisotopes with half-lives from 18 min to 24,000 yr have been investigated by the atomic beam flop-in method with radioactive detection. The nuclear spin measurements and hyperfine structure separation measurements including nuclear moment calculations are presented in table form. The tables are a composite of results of many researchers.

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California U. [Dept. of Physics] Berkeley.

HYPERFINE STRUCTURE SEPARATION AND MAGNETIC MOMENT OF (3.3-Hr) Cu^{61} (Abstract), by B. Dodsworth, V. J. Ehlers and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 353, Aug. 27, 1959.

The hyperfine structure splitting of 3.3-hr Cu^{61} has been measured by the method of atomic beam. The isotope was produced with the $(\alpha, 2n)$ reaction by bombarding Co^{60} with the 34 mev α beam from the Berkeley 60-in. cyclotron. Chemistry was performed to separate the Cu metal from the Co target. Resonances were observed by inducing transitions between the $m_F = -1$ and $m_F = -2$ members of the $F = 2$ levels, at fields of 57, 111, 126, 176 and 239 gauss. The radioactive atoms were collected on sulfur-coated buttons which were counted in sodium iodide crystal scintillation counters. $\Delta\nu$ was calculated using the Breit-Rabi formula, assuming positive and negative values of g_I . The assumed positive value of g_I gave the best fit to the data and resulted in a $\Delta\nu = 11,200 \pm 400$ mc/sec. Using the Fermi-Segrè formula and the results of Cox and Willaims, the magnetic moment of Cu^{61} was found to be: $\mu = + 2.12 \pm 0.08$ nm.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF 2.3-Hr IODINE-132 (Abstract), by H. L. Garvin, E. Lipworth, and W. A. Nierenberg. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 353, Aug. 27, 1959.

The nuclear spin of 2.3-hr iodine-132 has been measured by means of an atomic-beam magnetic-resonance experiment and found to have the value 4. The apparatus used for this measurement has been described elsewhere. Iodine-132 is conveniently obtained by a milking process from 77-hr tellurium-132 in an iodine generator provided by the Brookhaven National Lab. A

generator initially charged with 108 millicuries of I^{132} provided a sufficient quantity of active material to observe the "flop-in" resonances of the $F = 11/2$ and $F = 9/2$ hyperfine states of the $^2P_{3/2}$ atomic ground state at magnetic field values of 1.42, 2.82, 6.92, and 13.42 gauss. The I^{132} beam was detected by collection upon silver-coated buttons which were subsequently counted in continuous-flow proportional counters. Decay half life of both the principal sample and several resonance-maxima samples were used to reaffirm identification of the isotope. The observed value of 4 for the nuclear spin of I^{132} is consistent with the single-particle shell model of the nucleus.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF SAMARIUM-153 (Abstract), by A. Y. Cabezas, E. Lipworth and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 354, Aug. 27, 1959.

Hyperfine structure investigations of 47-hr Sm^{153} by the atomic-beam magnetic-resonance technique indicate that the nuclear spin of this nuclide is $I = 3/2$. In a low field search, 3 resonances were observed which were ascribed to transitions occurring in the $J = 1$ and $J = 2$ excited electronic states. With the flop-in magnet geometry used in this experiment, these resonances must be of a multiple quantum character. Each of the transitions was observed at 3 fields. The data indicates that the g_J value of both observed electronic states is 1.5, the value obtained in pure L-S coupling among the electrons of the configuration (5f). This configuration is the same as that inferred from optical spectroscopy.

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California U. [Dept. of Physics] Berkeley.

HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF BROMINE-82, by H. L. Garvin, T. M. Green and others. [1959] [9]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 116: 393-401, Oct. 15, 1959.

The nuclear spin, the magnetic dipole, and the electric quadrupole interaction constants have been measured

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for 35-hr bromine-82 by the method of atomic beams. The results are $I = 5$, $|a| = 205.04 \pm 0.05$ mc/sec, $|b| = 870.7 \pm 0.9$ mc/sec, and $b/a = -4.246 \pm 0.001$. The nuclear magnetic and electric quadrupole moments obtained from these values of a and b are $|\mu| = 1.6264 \pm 0.0005$ nm, and $|Q| = 0.76 \pm 0.03$ barn. While only the relative sign of μ and Q is determined, both μ and Q are almost certainly positive. A new method for solving the interaction Hamiltonian with magnetic field, for arbitrary I and J , by using an IBM 650 computer, is described. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

NUCLEAR SPIN, HYPERFINE-STRUCTURE SEPARATION, AND MAGNETIC MOMENT OF 22-HOUR POTASSIUM-43, by F. R. Petersen, V. J. Ehlers and others. [1959] [18]p. incl. diagrs. tables. (Rept. no. UCRL-8738) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission) Unclassified

Also published in Phys. Rev., v. 116: 734-737, Nov. 1, 1959.

With the atomic-beam magnetic-resonance method, the nuclear spin and hyperfine-structure separation have been measured for 22-hr K^{43} . The results are: $I = 3/2$, $\Delta\nu(^2S_{1/2}) = 192.64 \pm .05$ mc/sec. The nuclear magnetic moment calculated from these measurements is: $|\mu| = 0.163 \pm .002$ nuclear magnetons. (Contractor's abstract)

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF 16-Hr Am^{242} (Abstract), by J. Wincour, R. Marrus, and W. A. Nierenberg. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339], Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 451, Dec. 28, 1959.

The spin of 16-hr Am^{242} has been measured by the atomic-beam magnetic resonance method. The result is $I = 1$. The isotope is obtained from the $Am^{241}(n, \gamma) Am^{242}$ reaction on Am_2O_3 . A beam of atoms is produced by reducing the oxide with lanthanum metal. The radioactive beam is collected on freshly flamed thin platinum disks which are counted in continuous-flow

proportional counters. Three flop-in transitions were observed at several values of the magnetic field. Large quadratic shifts were observed in fields of only a few gauss, indicating a small hyperfine structure. This result is important in the light of the difficulties in interpreting the Am^{242} decay scheme and level structure.

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California U. [Dept. of Physics] Berkeley.

HYPERFINE STRUCTURE OF Ga^{67} AND Ga^{68} (Abstract), by V. J. Ehlers and W. A. Nierenberg. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 452, Dec. 28, 1959.

Hyperfine structure separations of 78-hr Ga^{67} and 68-min Ga^{68} have been measured by means of an atomic-beam magnetic-resonance experiment using radioactive detection. The Ga^{67} has been measured in both the $^2P_{3/2}$ and $^2P_{1/2}$ electronic states, allowing a determination of the differential hyperfine-structure anomaly $^{67}_{69}$, defined by $^{67}_{69} = \frac{\Delta_{1/2}^{67}}{\Delta_{3/2}^{67}} - \frac{\Delta_{1/2}^{69}}{\Delta_{3/2}^{69}}$. Ga^{68} has been measured in the $^2F_{3/2}$ state and has shown a very small magnetic moment causing an energy-level inversion. For an assumed positive magnetic moment, the decreasing energy level is $F = 5/2, 1/2, 3/2$. The values obtained are

$$\begin{aligned} &Ga^{67} \\ &^2P_{3/2} \quad a = 175.092 \pm 0.009 \text{ mc} \\ &^2F_{3/2} \quad b = 71.939 \pm 0.025 \text{ mc} \\ &^2P_{1/2} \quad \Delta\nu = 2457.733 \pm 0.030 \text{ mc} \\ &\quad \mu = +1.845 \pm 0.001 \text{ nm} \\ &\quad Q = +0.217 \pm 0.009 \text{ barn} \end{aligned}$$

$$\begin{aligned} &Ga^{68} \\ &^2P_{3/2} \quad |a| = 3.875 \pm 0.050 \text{ mc} \\ &^2P_{3/2} \quad |b| = 12.230 \pm 0.125 \text{ mc} \\ &^2P_{3/2} \quad b/a > 0 \\ &\quad |\mu| = 0.0272 \pm 0.0008 \text{ nm} \\ &\quad |Q| = 0.037 \pm 0.001 \text{ barn} \end{aligned}$$

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The nuclear moments are obtained from the Fermi-Segrè formula and the moments of Ga^{71} . The magnetic moments contain no diamagnetic correction. By using the interaction constants of Ga^{69} with our values for Ga^{67} yields $^{67}a_{69} = (6 \pm 5) \times 10^{-5} \%$.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF 9.9-Min Cu^{62} (Abstract), by B. Dodsworth, V. J. Ehlers and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339], Atomic Energy Commission, and Office of Naval Research)

Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 452, Dec. 28, 1959.

The spin of 9.9-min Cu^{62} has been measured by the atomic beam method as $I = 1$. The isotope was produced by decay of 9.3-hr Zn^{62} , which was formed by the reaction $Ni(\alpha, 2n) Zn^{62}$ by using 40-mev α particles. The Cu^{62} was extracted chemically every 60 min and electroplated from the solution. For normalization a small amount of 3.3-hr Cu^{61} was added to the chemistry. A comparison of the ratio of 9.9-min/3.3-hr material in the oven sample with the ratio of 9.9-min/3.3-hr material in the spin sample then indicated the presence or absence of a resonance. A resonance was indicated by an enrichment of Cu^{62} (spin 1) with respect to Cu^{61} (spin 3/2) in the spin sample. In the spin search, each oven load was exposed on a single button at a radiofrequency corresponding to a particular value of spin. Spin values of 0, 1, 2, or 3 were tried at several values of the field. The sample corresponding to spin 1 consistently showed an enrichment of the Cu^{62}/Cu^{61} ratio over that of the oven sample.

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California U. [Dept. of Physics] Berkeley.

NUCLEAR SPIN OF YTTRIUM-90 (Abstract), by F. R. Petersen and H. A. Shugart. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)339] and Atomic Energy Commission)

Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 452, Dec. 28, 1959.

The nuclear spin $I = 2$ for radioactive yttrium-90 ($T_{1/2} = 64$ hr) has been measured in the electronic states $^2D_{5/2}$ and $^2D_{3/2}$ by the atomic-beam magnetic-resonance method. The low-frequency "flip-in" resonances that were observed correspond to the transitions $F, m_F = 9/2, -3/2 \leftrightarrow 9/2, -5/2$ and $F, m_F = 7/2, -1/2 \leftrightarrow 7/2, -3/2$ in the $^2D_{5/2}$ state and to the transitions $F, m_F = 7/2, -3/2 \leftrightarrow 7/2, -5/2$ in the $^2D_{3/2}$ state. All transitions were observed at fields of 8.5 and 17 gauss. Certain transitions observed at higher fields have given preliminary values for the interaction constants a and b . The radioactive isotope was produced from the stable metal by the reaction $Y^{89}(n, \gamma) Y^{90}$ in the Livermore pool-type reactor. Resonance detection was accomplished by collecting the radioactive atoms on sulfur-coated "buttons" which were later counted in continuous-flow beta counters. All spin buttons were decayed to verify the identity of the radioactivity.

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California U. [Dept. of Physics] Berkeley.

FERMI ACCELERATION OF ELECTRONS IN THE OUTER VAN ALLEN BELT, by J. A. Crawford. [1959] 6p. (AFOSR-TN-59-1278) [AF 49(638)508] AD 243992

Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 360, Aug. 27, 1959.

Also published in Phys. Rev. Lett., v. 3: 316-318, Oct. 1, 1959.

Interface instabilities associated with arriving and departing magnetic storm clouds generate a strong Fermi acceleration which "dumps" all Van Allen electrons of the outer belt that are trapped on magnetic lines anchored in the earth. For this reason among others, the decay of albedo neutrons can account only for the inner belt which remains essentially undisturbed. This "sweeping" action of storms suffices to explain the presence of a gap between the belts. Thus the exterior electron belt must initially be trapped in the closed magnetic loops left behind by the decaying storm. These loops decay in turn, depositing their radiation in the geomagnetic field. The 1-ev storm electrons originally trapped in the loops undergo a Fermi acceleration produced by the departing cloud. This leads very quickly to high energies and accounts satisfactorily for the radiation observed in the outer belt, collisions between electrons being duly taken into account in the complete Fokker-Planck

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equation. Thus it is unnecessary to assume that this radiation must be transported somehow from the sun. (Contractor's abstract)

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California U. Dept. of Physics, Berkeley.

CYCLOTRON RESONANCE IN ALUMINUM, by D. N. Langenberg and T. W. Moore. [1959] [2]p. incl. diagrs. (AFOSR-3411) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)600] and Office of Naval Research) AD 613118 Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 137-138, Aug. 1, 1959.

Cyclotron resonance in a single crystal sample of aluminum at 24 kmc/sec and 4.2°K is observed. Both absorption and absorption-derivative measurements were made the latter using magnetic field modulation. It is shown that at fields above 2 kilo-oersteds, the absorption curve shows a component periodic in $1/H$ superimposed on a monotonically decreasing component. The oscillations, which can be seen more clearly on the absorption-derivative curve, correspond to a cyclotron mass of $1.5 m_0$ and an $\omega\tau$ of about 10. The dependence of the resonance on sample orientation with respect to the magnetic field was also explored. Present data did not permit a detailed analysis, but several general statements are presented concerning the resonance, its area of resolution and other related facts.

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California U. Dept. of Physics, Berkeley.

CYCLOTRON RESONANCE IN COPPER, by D. N. Langenberg and T. W. Moore. [1959] [3]p. incl. diagrs. table. (AFOSR-3412) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)600] and Office of Naval Research) Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 328-330, Oct. 1, 1959.

A series of resonances up to the 12th harmonic were found at 24 kmc/sec in an artificially grown Cu crystal with its surface parallel to a (110) plane. The observed masses vary between $0.5 m_0$ and $5 m_0$; most lie between $1.1 m_0$ and $1.4 m_0$. For most orientations, except along the (100), (110) and (111) axes, 2 masses are resolved. The general behavior agrees well with that expected.

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California U. Electronics Research Lab., Berkeley.

STEADY STATE TRANSMISSION THROUGH A NET-

WORK CONTAINING A SINGLE TIME VARYING ELEMENT, by C. A. Desoer. Dec. 22, 1958 [31]p. incl. diagrs. tables, refs. (Series no. 60; issue no. 221) (AFOSR-TN-59-106) (AF 18(600)1521) AD 210388; PB 139993 Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 5-7, 1959.

Abstract published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 299, July 1959.

Also published in I.R.E. Trans. on Circuit Theory, v. CT-6: 244-252, Sept. 1959.

A new method of steady state analysis of a linear network, of arbitrary degree of complexity, containing a single periodically varying element is presented. The method makes full use of circuit theoretic ideas, such as impedance matching and tearing apart and of iterating techniques which are particularly suitable for automatic computation. The method has the additional feature of leading to the amplitude and phase of all side bands and of giving a bound on the error if the iterations are stopped at any particular point. More precisely, it is shown that, provided the impedance seen by the time varying element becomes capacitive at very high frequencies, the complete solution can be found within an arbitrary amount of accuracy.

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California U. Electronics Research Lab., Berkeley.

THE BANG-BANG SERVO PROBLEM TREATED BY VARIATIONAL TECHNIQUES, by C. A. Desoer. Nov. 2, 1959 [16]p. incl. diagr. table, refs. (Series no. 60; issue no. 257) (AFOSR-TN-59-408) (AF 18(600)1521) AD 238347 Unclassified

Also published in Inform. and Control, v. 2: 333-349, Dec. 1959.

Variational techniques are used to establish the following result: suppose a dynamical system is governed by the differential equation $\dot{y} = Ay + f(t)$ where A is a real constant matrix with distinct eigenvalues. Suppose that these eigenvalues are further restricted to have non-positive real parts but are not required to be purely real. Finally let each component $\phi_i(t)$ of the vector forcing function $f(t)$ satisfy, for all t , the conditions $|\phi_i(t)| \leq \gamma_i$ ($i = 1, 2, \dots, n$) where the γ_i 's are preassigned constants. It is shown that, given an arbitrary initial condition $y(0)$, the forcing function that will bring the system to its equilibrium position in the shortest possible time is such that $\phi_i(t) = \pm \gamma_i$, and the instants of time at which $\phi_i(t)$ changes from $\pm \gamma_i$ to $\mp \gamma_i$ are obtained by considering the output of the adjoint system. Further relationship between the given system and the adjoint system is discussed. It is also shown that this solution, obtained by variational techniques, implies the concept of switching surfaces. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

MODES IN LINEAR CIRCUITS AND LINEAR SAMPLED DATA SYSTEMS, by C. A. Desoer. July 27, 1959 [43]p. incl. diagrs. refs. (Series no. 60; issue no. 244) (AFOSR-TN-59-849) (AF 18(600)1521) AD 227707; PB 144493 Unclassified

Also published in I.R.E. Trans. on Circuit Theory, v. CT-7: 211-223, Sept. 1960.

A concept of modes in linear circuits is developed. The contribution of this paper is to show that provided a suitable point of view is taken, the concept of modes does apply indeed to any linear circuit: more precisely, it shows that it applies to any lossy or lossless, active or passive, reciprocal or nonreciprocal circuit. The importance of the mode concept lies in the fact that it allows one to consider a linear circuit as a whole, to break up its behavior as a sum of very simple patterns, and to visualize easily the effect of externally applied forces. Furthermore it provides a very informative description of the resonance phenomenon. In particular it is shown that (1) any free oscillation of a linear circuit can be thought of as a superposition of non-interacting modes of oscillation, (2) in the case of free oscillations the amount of excitation of each mode can easily be determined on the basis of initial conditions, (3) any forcing function can be considered as exciting each mode independently, and (4) the resonance phenomenon can be given a very simple interpretation pointing out, in particular, the importance of the proper type of excitation. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

THE OPTIMUM FORMULA FOR THE GAIN OF A FLOW GRAPH OR A SIMPLE DERIVATION OF COATES' FORMULA, by C. A. Desoer. July 6, 1960 [7]p. incl. diagrs. (Series no. 60; issue no. 295) (AFOSR-TN-59-851) (AF 18(600)1521) AD 241087 Unclassified

Also published in Proc. Inst. Radio Engineers, v. 48: 883-889, May 1960.

Starting from the definition of a determinant and using a few of its elementary properties, this paper gives an independent and simpler derivation of the optimum formula for the gain of a flow graph. The following set of linear algebraic equations are solved by topological

methods:
$$\sum_{j=1}^n a_{kj} x_j - b_k = 0 \quad (k = 1, 2, \dots, n).$$
 A flow

graph is then associated to this set of equations which is derived as a set of weighted oriented branches which connect nodes. That is, each branch has a positive direction and a weight, the branch gain. The first 5 sections of this paper use exclusively Coates' procedure

for associating a flow graph to a system of equations. Section VII discusses the difference between Mason's signal-flow graphs and Coates' flow graphs; it shows how either one may easily be obtained if the other is given.

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California U. Electronics Research Lab., Berkeley.

RECENT ADVANCES IN THE FIELD OF SAMPLED-DATA AND DIGITAL CONTROL SYSTEMS, by E. L. Jury. Oct. 20, 1959, 37p. incl. diagrs. refs. (Series no. 60; issue no. 256) (AFOSR-TN-59-1917) (AF 18(600)1521) AD 233272; PB 146738 Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (U.S.S.R.), 1960.

Also published in Automatic and Remote Control, v. 1: 262-269, 1960.

Theoretical aspects are described of the progress made in the field of sampled-data and digital control systems during the last few years. The material is classified into the following major topics: (1) linear theory, (2) statistical theory, (3) nonlinear theory, (4) time-varying theory, and (5) digital control systems. The above mentioned topics are briefly described and methods of analysis and design with their major purposes and achievements are enumerated. Each category is documented with a brief list of references which might serve as a quick aid to new investigators in this field. A brief survey of digital control systems is discussed, and it is indicated how the above mentioned topics can be extended to these systems. (Contractor's abstract)

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California U. [Electronics Research Lab.] Berkeley.

THE STABILITY AND COMPENSATION OF SATURATING SAMPLED-DATA SYSTEMS, by F. J. Mullin. [1959] [9]p. incl. diagrs. (AF 18(600)1521) Unclassified

Presented at Winter General meeting of the AIEE, New York, Feb. 1-6, 1959.

Published in Trans. Amer. Inst. Elec. Engineers, v. 78 (Part I): 270-278, July 1959.

Sampled-data feedback systems which contain a saturating element are investigated. A condition which must be satisfied if these systems are to be stable is developed. It is shown that this is a necessary condition for stability and an intuitive argument is presented to indicate that this condition is probably sufficient. Finally, a method to obtain a digital filter for compensating and/or stabilizing these systems is presented. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

ON THE COUPLING COEFFICIENTS IN THE "COUPLED-MODE" THEORY, by A. Yariv. [1958] [2]p. [AF 49(638)102] Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 1956-1957, Dec. 1958.

The coupling coefficients which govern the energy exchange phenomena between traveling waves are evaluated, using Pierce's coupled-mode theory (Jour. Appl. Phys., v. 25: 179-183, Feb. 1954). Results are obtained for traveling-wave tubes and double-stream amplifiers.

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California U. Electronics Research Lab., Berkeley.

THEORY OF MASER OSCILLATION, by J. C. Kemp. Nov. 30, 1959 [4]p. incl. diagr. (Series no. 60; issue no. 259) (AFOSR-TN-59-366) (AF 49(638)102) AD 231273 Unclassified

Also published in Jour. Appl. Phys., v. 30: 1451-1452, Sept. 1959.

The mechanism responsible for the amplitude modulated nature of the signal from an inverted spin system undergoing maser oscillation or coherent spontaneous emission was studied theoretically. It is shown that the observed waveforms are due to large amplitude mutations of the magnetization vector.

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California U. Electronics Research Lab., Berkeley.

RADIATION DAMPING EFFECTS IN TWO LEVEL MASER OSCILLATORS, by A. Yariv, J. R. Singer, and J. [C.] Kemp. [1959] [1]p. (AF 49(638)102) Unclassified

Published in Jour. Appl. Phys., v. 30: 265, Feb. 1959.

A re-examination is made of the phenomenon concerning the appreciable amplitude modulation oscillation resulting from an inverted 2-level spin system which is permitted to radiate spontaneously. It is found that the linearized coupling between the spin system and the cavity explanation, which assumes M_z to be a constant, predicts modulated oscillation only for the case $M_z = +M_0$ and not for the 2-level maser case where $M_z = -M_0$. It is believed that the explanation of the phenomenon lies in the nonlinear solution of the equations of motion presented, in which M_z is allowed to vary with time.

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California U. Electronics Research Lab., Berkeley.

PROPOSAL FOR A TUNABLE MILLIMETER WAVE MOLECULAR OSCILLATOR AND AMPLIFIER, by J. R. Singer. [1959] [5]p. incl. diagr. refs. (AF 49(638)102) Unclassified

Published in I.R.E. Trans. on Microwave Theory and Tech., v. MTT-7: 268-272, Apr. 1959.

An atomic beam apparatus suitable for a millimeter wave generator is theoretically discussed. The beam consists of atoms having a net magnetic moment. The upper and lower Zeeman levels of the atomic beam in a magnetic field are spatially separated by an inhomogeneous magnetic field. The upper state atoms enter a cavity where transitions occur at a frequency determined by a static magnetic field. The resonant frequency of the cavity is set at the transition frequency. The positive feedback of the cavity allows operation as an oscillator. Some of the more important parameters for oscillator operation are evaluated. The upper frequency limit is determined primarily by the resonant structure design. (Contractor's abstract)

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California U. [Electronics Research Lab.] Berkeley.

THIN FILM MAGNETIZATION ANALYSIS, by K. Chu and J. R. Singer. [1959] [8]p. incl. diagrs. refs. [AF 49(638)102] Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 1237-1244, July 1959.

A "graphical method" is used for analysis of the magnetization direction in terms of the magnetic energy, and for prediction of the hysteresis loop shape of ferromagnetic thin films. Three major magnetization conditions are discussed: (1) condition of magnetization with an 180° field applied; (2) condition of magnetization with a 90° field applied; and (3) condition of magnetization with both the 90° and the 180° field applied. Corresponding to these magnetization conditions, the hysteresis loop shapes are predicted and constructed showing close identity to those experimentally observed. These conditions are chosen because of their importance to computer applications. In the graphical method, the principle of superposition applies. Using this method, the magnetic energy relationships are readily established. The general expression for the total free energy equation is: $E_t = E_k + E_\sigma + E_{H\theta}$ where E_k is the anisotropy energy, E_σ is the magnetostriiction energy, and $E_{H\theta}$ is the magnetization energy.

Since the method of construction of the total free energy curve as well as the hysteresis loop is simple and mechanical, a quite complex magnetization condition with a multiplicity of fields of differing magnitudes and directions may be simplified and handled by graphical means with ease. Thus, the present scheme should be a

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practical and useful tool for analysis and engineering design of magnetic devices and systems utilizing ferromagnetic thin films. (Contractor's abstract)

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California U. Electronics Research Lab., Berkeley.

EXPERIMENTAL PROCEDURE FOR THE DETERMINATION OF CAVITY PARAMETERS, by A. Yariv and F. D. Clapp. [1959] [4]p. incl. illus. diags. [AF 49-(638)102] Unclassified

Published in Rev. Scient. Instr., v. 30: 684-687, Aug. 1959.

A new experimental procedure for the determination of cavity parameters is described. The procedure follows the basic steps described by Slater. In this method one measures the frequencies at which the voltage standing wave ratio at the input to the cavity reaches a predetermined value. The knowledge of these frequencies coupled with a determination of the state of coupling to the cavity yields the necessary information. An exposition of some pertinent theoretical points is followed by a detailed description of the experimental procedure. (Contractor's abstract)

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California U. Inst. of Engineering Research, Berkeley.

SELF-DIFFUSION IN NICKEL SINGLE CRYSTALS, by A. Messner, R. Benson, and J. E. Dorn. July 15, 1959, 12p. incl. diags. table. (Technical rept. no. 2; series no. 114; issue no. 2) (AFOSR-TN-59-1005) (AF 49(638)58) AD 225174 Unclassified

Using a sensitive surface monitoring technique, the volume diffusivity of Ni (63) into single Ni crystals was found to be given by $D = 5.8 \exp(69,700/RT)$ over the temperature range from 680°C to 830°C. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

VECTOR POLAR METHOD FOR SHOCK INTERACTIONS WITH AREA DISTURBANCES, by A. K. Oppenheim and P. A. Urtiew. July 1959, 1v. incl. diags. tables, refs. (Technical note no. DR 4) (AFOSR-TN-59-701) (AF 49(638)166) AD 220405; PB 143670 Unclassified

The application of the vector polar method to the study of interactions between plane traveling shock waves and area disturbances involves the introduction of steady flow polars. The study covers first the interaction of shock waves with single area disturbances, that is divergences or convergences placed between 2 constant area tubes. Resulting wave systems for the whole field

of area ratios, R , and incident shock Mach numbers, M_1 , are described. Representative cases are evaluated by the vector polar method and the regimes of solutions delineated on the $R - M_1$ diagrams for perfect gases

with constant specific heats. These interactions with convergent-divergent nozzles are treated in a similar manner. The solutions obtained by the vector polar method are shown to compare favorably with analytical and experimental results obtained by other investigators who studied the interactions of shocks with a variety of obstacles, such as grids and gauzes, in shock tubes. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

FUNDAMENTALS OF THE POLAR METHOD IN GAS WAVE DYNAMICS, by R. A. Stern and A. K. Oppenheim. Nov. 1959 [95]p. incl. diags. tables, refs. (Technical note no. DR-5) (AFOSR-TN-59-1152) (AF 49(638)166) AD 230888; PB 145544 Unclassified

Gas wave dynamics is concerned with the analysis of interactions between waves propagating in compressible and reacting media. Multiple interactions, such as those occurring in shock tubes or during the development of detonation, require solutions by analysis which considers only the compatibility conditions for the wave system resulting from each interaction without any regard for the details of its progress. These dynamic boundary conditions are expressed in terms of invariance relations between equilibrium states across each component wave. For the solution of the wave system they have to be pieced together, either numerically by an iterative procedure, or graphically by the polar method. The present study introduces the fundamentals of the polar method. It consists of (1) the formulation of the basic problem leading to the establishment of invariance relations in the general case of a wave process, (2) the derivation of invariance relations for an elementary wave process in the general case of a compressible and reactive medium, and (3) the illustration of the analysis by the derivation of invariance relations for 2 special cases of simple waves: 1 with friction and the other with chemical reaction. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

STATISTICAL STUDY OF ACCELERATING FLAMES. ANALYSIS OF VARIANCE, by R. A. Stern, A. J. Laderman, and A. K. Oppenheim. Nov. 1959 [73]p. incl. diags. tables, refs. (Technical note no. DR-6) (AFOSR-TN-59-1171) (AF 49(638)166) AD 230889; PB 145637 Unclassified

Also published in Phys. Fluids, v. 3: 113-120, Jan.-Feb. 1960.

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The study of velocity fluctuations observed by means of ionization probes during the development of detonation reveals its significance as an indicator of physical characteristics of the flame. The scatter in time of arrival-the reciprocal of the velocity-was found normally distributed at an 85% probability level. The means and standard deviation were determined within 5% and 20% respectively at a confidence level of 90%. The intensity of scatter is interpreted consequently as indicative of the combustion front fluctuation that can be considered to delineate the effective flame thickness. It is found then that as the flame accelerates, its effective thickness 1st increases, reaching a maximum in the vicinity of velocity overshoot, and then decreases, attaining finally a minimum, constant value when the steady detonation wave is established. An interesting bimodal distribution of scatter for the $2H_2 - O_2$ mixture has been observed, indicating a possible existence of 2 alternative, independent modes for the development of the process. The results of the study are used to establish the requirements for more detailed, systematic investigation of the fluctuating characteristics of accelerating flame fronts. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

PECULIARITY OF SHOCK IMPINGEMENT ON AREA CONVERGENCE, by A. K. Oppenheim, P. A. Urtiew, and R. A. Stern. 1959 [5]p. incl. diagrs. refs. (AFOSR-TN-59-1187) (AF 49(638)166) AD 230900

Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 361, Aug. 27, 1959.

Also published in Phys. Fluids, v. 2: 427-431, July-Aug. 1959.

General study of wave systems which can result from the interaction of plane shock with an area convergence has led to the discovery of an interesting regime, specified in terms of functional relationships between shock Mach numbers and area ratios, where two or three solutions exist at the same time, all satisfying the dynamic boundary conditions imposed by the conservation laws. The ambiguity is resolved by invoking the extremum principle of irreversible thermodynamics. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

IONIZATION WORLD LINES IN GASEOUS PREDETONATION (Abstract), by G. J. Hecht, A. J. Laderman and others. [1959] [1]p. [AF 49(638)166]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 364, Aug. 27, 1959.

The techniques and apparatus required to extend the use of "pin or gap" type ionization detectors to yield reliable timing signals throughout the predetonation zone in detonation tube research with gaseous mixtures is fully described. Accurate timing signals in this zone provide direct data for a recent analysis by Oppenheim and Stern of the events leading up to detonation. Their analysis rests solely on the space-time history or "world lines" of flame fronts, shocks, rarefactions, and contact discontinuities. A consideration of the mechanisms of ionization in the predetonation zone is presented and it is shown that flame induced ionization can be distinguished unambiguously from that due to shocks on the basis of pulse amplitude of the signals appearing at the detectors. Design and construction of the probes, amplifier-thyratron timing channels, and operational requirements are presented. Precision of the apparatus is shown to be better than 2% throughout the entire predetonation zone. Experiments with H_2-O_2 mixtures are described and the results shown to yield the flame world line.

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California U. Inst. of Engineering Research, Berkeley.

THEORY OF THE STAGNATION POINT LANGMUIR PROBE, by L. Talbot. Mar. 30, 1959, 27p. incl. diagrs. refs. (Rept. no. HE-150-168, series no. 132, issue no. 1) (AFOSR-TN-59-474) (AF 49(638)502) AD 215717; PB 142263

Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 365, Aug. 27, 1959.

Also published in Phys. Fluids, v. 3: 289-298, Mar.-Apr. 1960.

The theory of the stagnation point Langmuir probe is developed to show that measurements made with such a probe can be used to determine free stream ion concentration and temperatures in a supersonic plasma jet stream. From the analysis, it appears that a variation in probe potential will produce a variation in heat transfer which may prove useful in plasma jet diagnostics. A sample computation is given to illustrate the application of this theory and to exhibit orders of magnitude of the quantities of interest.

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California U. Inst. of Engineering Research, Berkeley.

LOW DENSITY SUPERSONIC DIFFUSER PERFORMANCE, by A. M. Collins. Jan. 15, 1959 [16]p. incl. illus. diagrs. refs. (Rept. no. HE-150-164; series no. 20, issue no. 126) (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) AD 215973 Unclassified

The impact pressure and static pressure recoveries of a supersonic, converging-diverging diffuser were measured in the range $M = 1.7 - 4.1$, $Re_L = 500 - 3200$. The Reynolds number was with respect to the leading edge diam. It was found that, for subsonic flow in the back end of the diffuser, normal shock static and impact pressure recoveries were the best that could be obtained. Afterglow photographs were taken of the low density flow inside the transparent plastic diffuser. (Contractor's abstract)

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California U. Inst. of Engineering Research, Berkeley.

HEAT TRANSFER, RECOVERY FACTOR, AND PRESSURE DISTRIBUTIONS AROUND A CYLINDER NORMAL TO A SUPERSONIC RAREFIED-AIR STREAM. PART I. EXPERIMENTAL DATA, by O. K. Tewfik and W. H. Giedt. Jan. 30, 1959, 1v. incl. illus. diagrs. tables. (Rept. no. HE-150-162; series no. 20, issue no. 124) ([Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research] under Nonr-22245) AD 214435 Unclassified

Local heat transfer, recovery factor, and pressure distributions around a circular cylinder normal to a supersonic rarefied air stream were measured from $M = 1.3$ to 5.9 , from $Re = 37$ to 4100 , and at 2 cylinder wall average temperature levels of 90° and $210^\circ K$ under steady state thermal and flow conditions. A correlation equation for the stagnation point Nusselt number was determined in terms of Reynolds number just after the normal part of the detached bow shock wave, or in terms of the undisturbed stream Mach and Reynolds numbers. Empirical expressions for the local heat transfer coefficient and coefficient of pressure distribution around the entire cylinder surface were obtained in the form of a Fourier series. Effects of cylinder wall temperature level and gradient on the heat transfer and pressure distribution are discussed.

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California U. Inst. of Engineering Research, Berkeley.

OXYGEN RECOMBINATION PROGRAM, by S. A. Hoenig. Mar. 23, 1959 [42]p. incl. illus. tables, refs. (Rept. no. HE-150-163; series no. 20, issue no. 125) (Sponsored

jointly by Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) AD 216800 Unclassified

A program was initiated to measure the catalytic efficiency for a series of surfaces which would simulate the condition that will exist on a high speed aircraft at extreme altitudes. The study is concerned with the effects of the vehicle surface on the aerodynamic flow. These effects can arise from 2 causes: (1) the flight Mach number may be so high that a significant fraction of the air which passes through the shock wave is dissociated or ionized, or (2) the air itself may consist not of diatomic oxygen and nitrogen, but of free atoms of these substances. The catalytic efficiency is defined as the ratio of the number of reactions occurring on the surface per unit time to the total number of collisions of reactive species with the surface per unit time. An experimental apparatus was designed to measure the catalytic properties of various metals toward gaseous recombination. The equipment consists of a series of valves through which the test gas is drawn to reduce the pressure, and a silica-gel dryer to remove water-vapor. The gas flows through a heater, then to a stagnation chamber and effuses into the test tank. The probe assembly consists of a plexiglass disc which supports the 2 thermistors, which in turn carry the probes. A wheatstone bridge is also used with the thermistor forming one arm. (ASTIA abstract)

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California U. Inst. of Engineering Research, Berkeley.

DESIGN, FABRICATION, AND EVALUATION OF AXI-SYMMETRIC NOZZLES, by L. L. Lynes. Sept. 10, 1959, 1v. incl. illus. tables. (Rept. no. HE-150-174; series no. 20, issue no. 132) (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under Nonr-22245) AD 225224 Unclassified

The pumping capacity of the no. 3 wind tunnel was increased in 1954 in order to accommodate a Mach 6 nozzle of a usable test section size. This increased capacity left the previous nozzles still usable in their own range, but with a smaller test section size than would have been available with the increased capacity. Since it is most desirable to have as large a test section as possible, it is necessary to have the nozzles designed at max capacity. Scaling procedures are given for increasing the size of the existing nozzles to meet the increased capacity. This was accomplished by application of scaling laws to a Mach 4 nozzle, followed by fabrication and experimental evaluation of the resulting nozzle. (Contractor's abstract)

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California U. [Inst. of Engineering Research] Berkeley.

VISCOUS INTERACTION EXPERIMENTS AT LOW REYNOLDS NUMBERS, by S. A. Schaaf, F. C. Hurlbut

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and others. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Bell Aircraft Corp., and Office of Naval Research under [Nonr-22245])
Unclassified

Published in ARS Jour., v. 29: 527-528, July 1959.

Data are presented which suggest that slip flow phenomena occur at the sharp leading edge of a flat plate at zero angle of attack in supersonic flow. Disturbance of pressure due to boundary layer displacement is shown to result in slip above certain limiting values of surface pressure.

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California U. Minerals Research Lab., Berkeley.

ARC IMAGE FURNACE, by D. O. Horning and E. R. Parker. Final rept. May 1959 [22]p. incl. illus. diagrs. table, refs. (Series no. 141) (AFOSR-TR-59-88) (AF 18(603)123) AD 220856; PB 143622

Unclassified

An arc image furnace was designed to provide an uncontaminated high-intensity heated zone of appreciable size in the temperature range of 6000° to 10,000°K. "Uncontaminated" is inferred to cover conditions arising due to atmospheric pollutants and electrical or magnetic influences. The furnace consists of an external spherical shell and vacuum system, paraboloid mirror mounts, arc container, power supply, and preliminary instrumentation. The initial low-power operation and calibration were completed. The furnace is to be tested at high arc current rates in final tests. The initial low-power operation and calibration indicate that the final tests should be successful.

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California U. Minerals Research Lab., Berkeley.

INTERNAL STRESSES IN MODEL CERAMIC SYSTEMS II. A. X-RAY STRAIN MEASUREMENT TECHNIQUES FOR CERAMIC BODIES. B. EXTENDING THE RANGE OF REPLICATION TECHNIQUES, by L. N. Grossman, R. M. Fulrath, and R. B. Langston. Technical progress rept. no. 2, Oct. 1, 1959, 1v. incl. illus. diagrs. tables, refs. (Series no. 119; Issue no. 2) (AFOSR-TN-59-1181) (AF 49(638)4) AD 229892; PB 145018

Unclassified

Pt. A also published in Jour. Amer. Ceram. Soc., v. 44: 567-571, Nov. 1961.

Part A. X-ray diffractometer techniques for measuring triaxial and biaxial strain in ceramic bodies are described. The results of the techniques as applied to model ceramic systems using Al_2O_3 and ThO_2 crystal phases with various glasses in the $Na_2O-B_2O_3-SiO_2$ system are presented. It is shown that internal stresses

due to expansion coefficient mismatches occur in these systems and that their magnitudes often exceed the bulk strength of the body. Further applications of the techniques are discussed. Part B. In a progress report on obtaining the microstructures of model ceramic systems used in the investigation of internal stresses in ceramics, it is concluded that: (1) The microstructures of polished ceramic specimens could not be observed until etchants were used to produce relief and difference in texture. (2) Preparation of a number of replicas from the same surface allows simultaneous studies of the microstructure under a wide range of magnifications. (3) Differences in relief and texture, which allows one to study particle size, packing, and orientation, were best observed using oblique lighting and shadowing techniques. (4) Carefully controlled studies on etchants and etching techniques are necessary to obtain the microstructural information on ceramic systems with and without the use of replicas.

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California U. Minerals Research Lab., Berkeley.

THE EFFECT OF IMPURITIES ON THE STRENGTH OF SILVER CHLORIDE, by W. J. Luhman and A. E. Gorum. [1959] [3]p. incl. diagrs. (Contribution no. 98; IER reprint no. 20-60) (AFOSR-4397) (AF 49(638)56)
Unclassified

Published in Acta Metall., v. 7: 685-687, Oct. 1959.

The results of investigations to obtain the effect of small impurity additions on the stress-strain characteristics of a representative ionic material are presented. It is shown that all additions caused AgCl to become more light sensitive. Silver bromide was easily added to AgCl in any proportion while the other materials, if added in great amounts, would cause decomposition. Different addition materials gave different effects and different proportions of the same additive gave different results. Some rather large changes in lattice parameter were noted in some cases. It was noted that the effect of these additions on the stress-strain curve is similar to that found in metal solid systems.

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California U. Minerals Research Lab., Berkeley.

FRACTURE OF CERAMIC MATERIALS, by E. R. Parker. [1959] [12]p. incl. illus. diagrs. refs. [AF 49-(638)56]
Unclassified

Published in Proc. Internat'l. Conf. on the Atomic Mechanisms of Fracture, Swampscott, Mass. (Apr. 12-16, 1959), Cambridge, MIT Technology Press, 1959, p. 181-192.

The microscopic observations of deformed and etched MgO single crystals are described. It is stated that etch-pit studies reveal slip bands densely populated with

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dislocations and that these slip bands act as barriers to dislocations on intersecting slip planes. Cleavage cracks on (001) and (011) planes are found at the junctions on intersecting slip bands. The formation of these cracks is evidently associated with the high local stresses produced by dislocation pile-ups. (Contractor's abstract)

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California U. Minerals Research Lab., Berkeley.

HIGH TEMPERATURE HEAT CONTENTS OF SOME BINARY IRON ALLOYS, by W. B. Kendall, R. L. Orr, and R. Hultgren. July 1, 1959, 14p. incl. tables. (Technical note no. 2; series no. 137; issue no. 2) (AFOSR-TN-59-524) (AF 49(638)83) AD 216258; PB 143672

Unclassified

Although the detailed behavior of the heat capacity in regions of thermal anomalies is, in general, poorly defined by heat content measurements, the Curie temperatures derived from the present data for $\text{Co}_{0.309}\text{Fe}_{0.691}\text{Cr}_{0.094}\text{Fe}_{0.906}$, and $\text{Fe}_{0.880}\text{Si}_{0.120}$ are in excellent agreement with those shown in the new edition of Hansen. The heat contents reported here have been measured with an average experimental precision of about $\pm 0.3\%$. As a result of the method used to calibrate the calorimeter, the experimental measurements are all referenced to the heat content of platinum; thus the absolute accuracy of the smoothed data is about the same order of magnitude as that for pure platinum (probably about $\pm 0.3\%$). Errors due to uncertainty in the sample composition are considered inconsequential, since small amounts of metallic impurities generally have a negligible effect on the heat content of an alloy. The hypothesis that the anomalous hump in each of the heat capacity curves of $\text{Fe}_{0.512}\text{Mn}_{0.488}$ and

$\text{Fe}_{0.696}\text{Mn}_{0.304}$ corresponds to an antiferromagnetic transformation could easily be checked by measuring the magnetic susceptibilities of these alloys over the temperature range of interest. A maximum in the susceptibility in the vicinity of the anomalously high heat capacities would clearly support such a hypothesis. (Contractor's abstract)

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California U. Minerals Research Lab., Berkeley.

THE HEAT CAPACITY OF DILUTE SOLUTIONS OF CHROMIUM IN NICKEL, by R. Hultgren and C. Land. July 1, 1959 [2p. incl. tables. (Technical note no. 1; series no. 137; issue no. 1) (AFOSR-TN-59-525) (AF 49(638)83) AD 216259

Unclassified

Also published in Trans. Metall. Soc. AIME, v. 215: 165-166, Feb. 1959.

Heat contents of four Cr-Ni alloys were determined in a diphenyl ether calorimeter. Aside from ferromagnetic

effects, Kopp's law of additivity of heat capacities is approximately followed, in disagreement with earlier results of A. W. Foster (Philos. Mag., v. 18: 470-488, Sept. 1934). (Contractor's abstract)

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California U. School of Public Health, Berkeley.

FURTHER STUDIES OF GASEOUS ION ACTION ON TRACHEA, by A. P. Krueger, R. F. Smith and others. [1959] [11p. incl. table. (AFOSR-TN-59-884) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)669 and Atomic Energy Commission) AD 230696

Unclassified

Also published in Proc. Soc. for Exper. Biol. and Med., v. 102: 355-357, 1959.

The trachea of the living rabbit was observed during exposure to un-ionized and ionized N_2 , O_2 and CO_2 using a separate airway for respiration. Positively charged CO_2 was found to be responsible for: reduction of ciliary activity, contracture of smooth muscle, ischemia and enhanced vulnerability to trauma. (Contractor's abstract)

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California U. School of Public Health, Berkeley.

SOME BIOLOGIC PROPERTIES OF GASEOUS IONS, by A. P. Krueger. [1959] [10p. incl. diagrs. refs. (AFOSR-TN-59-1143) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)669, Atomic Energy Commission, and National Institutes of Health) AD 142526

Unclassified

Also published in Jour. Albert Einstein Medical Center, v. 8: 79-88, Apr. 1960.

Positively and negatively charged atmospheric ions exert profound influences on ciliary activity, mucous flow and vulnerability to trauma of the living cells of the trachea. Original experiments suggest that these effects are mediated through cytochrome oxidase and possibly through local 5-hydroxytryptamine release and oxidation. (Contractor's abstract)

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California U. School of Public Health, Berkeley.

THE BIOLOGICAL MECHANISMS OF AIR ION ACTION. 1. 5-HYDROXYTRYPTAMINE AS THE ENDOGENOUS MEDIATOR OF POSITIVE AIR ION EFFECTS ON THE MAMMALIAN TRACHEA, by A. P. Krueger and R. F. Smith. [1959] [8p. incl. diagrs. refs. (AFOSR-TN-59-1300) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)669 and Atomic Energy Commission) AD 234189

Unclassified

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Also published in Jour. Gen. Physiol., v. 43: 533-540, Jan. 1960.

Intravenous administration of 5-hydroxytryptamine to rabbits and guinea pigs is shown to bring about changes very similar to those produced by (+) air ions, including (1) decreased ciliary rate, (2) contraction of the posterior tracheal wall, (3) exaggerated response of the tracheal mucosa to trauma, (4) marked vasoconstriction in the tracheal wall, and (5) increased respiratory rate. These effects are reversed by (-) air ions. Iproniazid, which raises 5-hydroxytryptamine levels in the animal by blocking monamine oxidase, produces similar but non-reversible effects. Reserpine, which depletes 5-hydroxytryptamine in the animal, causes changes that resemble those produced by (-) air ions, including (1) increased ciliary rate, (2) relaxed posterior sulcus, (3) hyperemia of the tracheal mucosa, (4) lowered respiratory rate, and (5) increased volume and rate of mucus flow. On the basis of these facts, the hypothesis is advanced that (+) air ion effects are mediated by the release of free 5-hydroxytryptamine, while (-) air ion effects depend on the ability of (-) ions to accelerate the enzymatic oxidation of 5-hydroxytryptamine. (Contractor's abstract)

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California U. Dept. of Astronomy, Los Angeles.

EFFICIENT PRECISION ORBIT COMPUTATIONAL TECHNIQUES, by R. M. L. Baker, Jr., G. B. Westrom and others. June 11, 1959, 1v. incl. diagrs. tables, refs. (Astrodynamical rept. no. 3) (AFOSR-TN-59-766) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)498 and Army Ballistic Missile Agency under DA-04-495-ORD-1389) AD 227519; PB 144014 Unclassified

Presented at meeting of the Amer. Rocket Soc., San Diego, Calif., June 8-11, 1959.

Also published in ARS Jour., v. 30: 740-747, Aug. 1960.

A comparison is made of the methods of Cowell, Encke and the variation-of-parameters for the computation of high-precision orbits. Analysis of the integration of an analytical 3-body trajectory and an analytical low-thrust spiral trajectory indicated the importance of decreasing the overall number of integration steps to avoid round-off errors. Comparative computations demonstrated that Encke's method is preferable in the ballistic lunar trajectory, variation-of-parameters in the low-thrust trajectory, and Cowell's method in the high-thrust trajectory. The overall computational efficiency of the Encke's and the variation-of-parameters method is also shown. (Contractor's abstract)

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California U. Dept. of Astronomy, Los Angeles.

THREE-DIMENSIONAL DRAG PERTURBATION TECHNIQUE, by R. M. L. Baker, Jr. July 1, 1959 [6]p. incl. diagr. refs. (Astrodynamical rept. no. 4) (AFOSR-TN-59-767) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)498 and Army Ballistic Missile Agency under DA-04-495-ORD-1389) AD 263780 Unclassified

Also published in ARS Jour., v. 30: 748-753, Aug. 1960.

The analysis of the application of an astronomical special perturbation technique to the entry of space vehicles (into a resistive medium) is extended to three dimensions. Furthermore, perturbations resulting from the asphericity of Earth and the rotation of Earth's atmosphere were explicitly included, and the effects of ablation, cross winds and lift are considered. Use of the variation-of-parameters perturbation technique allows for the more efficient and accurate computation of a large class of entry orbits. (Contractor's abstract)

253

California U. Dept. of Astronomy, Los Angeles.

DIFFERENTIAL EXPRESSIONS FOR LOW-ECCENTRICITY GEOCENTRIC ORBITS, by S. Herrick, L. G. Walters, and C. G. Hilton. June 11, 1959 [33]p. incl. diagrs. tables. (Astrodynamical rept. no. 2) (AFOSR-TN-59-768) (In cooperation with Aeronutronic, Newport Beach, Calif.) (AF 49(638)498) AD 227518; PB 144277 Unclassified

Also published in Proc. Tenth Internat'l. Astronaut. Congress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959), Vienna, Springer-Verlag, v. 1: 327-340, 1960.

In the planning and evaluation of a tracking complex for space vehicles, two functions are served by differential expressions relating uncertainties, errors, or corrections in selected orbital elements to corresponding uncertainties, errors, or corrections in the observed coordinates. These functions are: (1) The translation of orbit uncertainties into observed quantities, or vice versa, for an evaluation of ability to correct an orbit from given observations, or for an evaluation of the accuracy of an ephemeris based upon these observations. (2) The translation of residuals in observed coordinates into differential corrections to the orbital elements (or parameters). The analysis presented here is divided into two steps because of the need for data intermediate between the parameters and the ephemeris.

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California U. Dept. of Astronomy, Los Angeles.

PRECISION ORBITS AND OBSERVATION REDUCTION, by S. Herrick. June 11, 1959, 21p. (Astrodynamical rept. no. 1) (AFOSR-TN-59-769) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)498, Army Ballistic Missile Agency under DA-04-495-ORD-1389, National Aeronautics and Space Administration under NASA-204, Pacific Missile Range under NOas-59-6110-C, and Wright Air Development Center under AF 33(616)6005) AD 227517; PB 144278
Unclassified

The advantages and disadvantages (1) in the reduction of observations, (2) of "fixes", (3) triangulation, (4) assumed motions or orbits, (5) reduction to the center of the Earth, (6) and reference systems are discussed in the light of astrodynamical experience and the requirements of different types of orbit and of errors of observation. The differential correction is defined and outlined. The "fix" and "complete observations" are discussed in relation to the determination of orbits and compared with the differential correction. The provinces of observer and orbit analyst are differentiated. The need for accurate observations and reductions is stressed. (Contractor's abstract)

255

California U. Dept. of Astronomy, Los Angeles.

THE "ASTRONOMICAL UNIT" AND THE SOLAR PARALLAX, by S. Herrick, G. [B.] Westrom, and M. W. Makemson. Sept. 30, 1959, 25p. incl. diagrs. tables, refs. (Astrodynamical rept. no. 5) (AFOSR-TN-59-1044) (In cooperation with Aeronutronic, Newport Beach, Calif.) (AF 49(638)498) AD 234711; PB 148266
Unclassified

The pros and cons of utilizing laboratory or astronomical units in measuring distance and trajectory constants are discussed along with the best way of handling trajectory calculations in connection with specific orbit problems. The discussion covers both the classical astronomical determinations of the solar parallax and the possibility of new determinations based upon the recent radar contact with Venus and upon possible radar or transponder-assisted contacts with minor planets or vehicles in space.

256

California U. Dept. of Astronomy, Los Angeles.

FUNDAMENTALS OF ASTRODYNAMICS, by R. M. L. Baker, Jr. and M. W. Makemson. Sept. 30, 1959, 336p. incl. diagrs. tables, refs. (Astrodynamical rept. no. 6) (AFOSR-TN-59-1045) (In cooperation with Aeronutronic, Newport Beach, Calif.) (Sponsored jointly by Air Force

Office of Scientific Research under AF 49(638)498, Army Ballistic Missile Agency under DA-04-495-ORD-1389, and National Aeronautics and Space Administration under NAS-5-76 and NAS-1-204) AD 234696

Unclassified

An extensive report is made on astrodynamics, its history, nomenclature, practical applications, and fundamental techniques from an engineer or non-astronomer point of view. Emphasis is placed on the problems of space vehicle trajectories. In particular, the topics of minor planets, comets, astronomical constants, orbit determination, n-body problems, perturbation techniques, non-gravitational forces, observation theory, and application to interplanetary orbits are singled out for more complete discussion.

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California U. [Dept. of Astronomy] Los Angeles.

OBSERVATION REQUIREMENTS FOR PRECISION ORBIT DETERMINATION, by S. Herrick. [1959] [18]p. incl. refs. (AF 49(638)498) AD 234696
Unclassified

Published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 417-434. (AFOSR-TR-59-108)

An examination is made of such matters as triangulation, the use of incomplete observations, the nature and treatment of errors, the connection of observations with the dynamic center, the adequacy of current astronomical frames of reference and in general the definition and separation of the functions of observer and orbit analyst. In short, the observer should not apply general corrections which might be handled differently by other observers, or which might be more experimentally and judiciously treated by the analyst, who has a wider perspective over the situation. On the other hand, the smoothing out of accidental errors and compression of extensive data are definitely within the sphere of the observer. It is also pointed out that to achieve spot landings on the Moon, to establish and supply expeditions, bases and depots required for scientific and other purposes of the future, it is clear that improvements must be made in several directions including correction for imperfect burnout conditions and derivation of more precise geophysical and astronomical constants by means of accurate theories and observations.

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California U. Dept. of Chemistry, Los Angeles.

THE CRYSTAL STRUCTURE OF AMMONIUM CHLORITE AT -35°C, by R. B. Gillespie and K. N. Trueblood. Dec. 1958 [33]p. incl. diagrs. tables, refs. (Perchlorates technical note no. 5) (AFOSR-TN-59-103) (AF 18(600)857) AD 210385; PB 139996
Unclassified

Also published in Acta Cryst., v. 12: 867-872, Nov. 10, 1959.

The structure of ammonium chlorite has been determined using 3-dimensional Fourier and least squares refinement of the parameters. The previously published structure is shown to be incorrect. The crystals are tetragonal with space group $P4_2$, m , and 2 molecules in the unit cell of dimensions $a_0 = 6.35\text{\AA}$ and $c_0 = 3.78\text{\AA}$ at -35°C . The chlorite ion is triangular with the O-CL-O angle 110° and the CL-O distance 1.57\AA . Single crystals of ammonium chlorite decompose to crystalline ammonium chloride and ammonium chlorate which are found to be precisely oriented with respect to the original ammonium chlorite. A preliminary crystallographic examination of ammonium chlorate shows this substance to be trigonal, with $a_0 = 4.43\text{\AA}$ and $\alpha = 86.5^\circ$. The crystals appear to be isomorphous with potassium bromate, and thus the space group is probably $R3m$. (Contractor's abstract)

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California U. Dept. of Chemistry, Los Angeles.

REFINEMENT OF THE CRYSTAL STRUCTURES OF SODIUM CHLORATE AND POTASSIUM CHLORATE, by J. G. Bower, R. A. Sparks, and K. N. Trueblood. Jan. 1959, 28p. incl. tables, refs. (Perchlorates technical note no. 6) (AFOSR-TN-59-104) (AF 18(600)857) AD 210386; PB 139994 Unclassified

The crystal structures of sodium chlorate and potassium chlorate have been reinvestigated with 3-dimensional visual x-ray intensity data obtained with CuK α radiation. Each structure has been defined by Fourier and least squares methods. The dimensions of the chlorate ion in the 2 structures are the same within experimental error. In sodium chlorate the chlorate ion lies on a 3-fold axis, the Cl-O distance is 1.45_5\AA , with standard deviation of about 0.02\AA , and the O-Cl-O angle is $107.4^\circ \pm 1.50$. In potassium chlorate the ion lies on a mirror plane; the 2 independent Cl-O distances are $1.46_0 \pm 0.01$ and $1.46_1 \pm 0.03\text{\AA}$, and the 2 O-Cl-O angles are $108.1 \pm 1.1^\circ$ and $108.7 \pm 0.7^\circ$. Thus the marked asymmetry of the chlorate ion in potassium chlorate which was originally reported by Zachariasen (0.18\AA in bond distance and 21° in bond angle) does not in fact exist. The findings are in accord with the quadrupole spectrum measurements by Zeldes and Livingston, which indicate that the chlorate ion in potassium chlorate must possess very nearly a 3-fold axis of asymmetry. In sodium chlorate each sodium atom is surrounded by an octahedron of oxygen atoms, the 2-independent Na-O distances being 2.45 and 2.47\AA . In the potassium salt, the potassium atom has 9-nearest oxygen neighbors at distances of 2.78 to 3.11\AA . (Contractor's abstract)

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California U. Dept. of Chemistry, Los Angeles.

THE CRYSTAL STRUCTURE OF TETRACYANO-ETHYLENE, by D. A. Bekoe and K. N. Trueblood. Jan. 1959, 23p. incl. diagrs. tables, refs. (Perchlorates technical note no. 7) (AFOSR-TN-59-186) (AF 18(600)-857) AD 211326; PB 140316 Unclassified

Also published in Zeitschr. Krist., v. 113: 1-22, Apr. 1960.

Tetracyanoethylene, $(\text{NC})_2\text{C}=\text{C}(\text{CN})_2$, forms monoclinic crystals of space group $P2_1/n$, with $a = 7.51$, $b = 6.21$, $c = 7.00\text{\AA}$ and $\beta = 97^\circ 10'$. There are 2 centrosymmetric molecules in the unit cell. The structure was solved with the aid of a sharpened 3-dimensional Patterson synthesis and was refined by least-squares methods. The thermal vibration parameters resulting from the refinement were analyzed to provide approximate librational corrections to the apparent bond distances. The corrected distances, with their estimated standard deviations, are: the central double bond, $1.317 \pm 0.009\text{\AA}$; the 2 crystallographically independent C-C bonds, 1.454 ± 0.007 and $1.443 \pm 0.006\text{\AA}$; the 2 independent C-N bonds, $1.15 \pm 0.012\text{\AA}$. The larger standard deviations and lower precision for the latter bonds reflect uncertainties in the librational corrections. No atom in the molecule is as much as 0.01\AA from the least-squares plane through the molecule. (Contractor's abstract)

261

California U. Dept. of Chemistry, Los Angeles.

STUDIES OF THE STRUCTURES OF CRYSTALLINE PERCHLORATES AND RELATED SUBSTANCES, by K. N. Trueblood. Final technical rept. Jan. 1959, 17p. incl. refs. (AFOSR-TR-59-13) (AF 18(600)857) AD 210387; PB 140315 Unclassified

Investigations were conducted on crystal structures by x-ray diffraction techniques including (a) determination of x-ray diffraction patterns of lithium perchlorate trihydrate, anhydrous lithium perchlorate, silver perchlorate monohydrate, anhydrous silver perchlorate, and related substances, and also of simple molecular complexes, (b) analysis of the x-ray patterns by means of 3-dimensional Patterson or modified Fourier functions, and (c) work on new precise methods of structure refinement on high-speed computers.

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California U. Dept. of Engineering, Los Angeles.

YIELD SURFACE AND PLASTIC POTENTIAL OF METALS, by T. H. Lin. July 1959, 9p. incl. diagr. refs. (AFOSR-TN-59-714) (AF 49(638)20) AD 229478; PB 144931 Unclassified

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The coincidence of the plastic potential and yield surface for both single crystal and polycrystal aggregate is derived from the consideration of elastic strain and slips in individual crystals. Uniqueness in single crystals for incremental stress and strain is discussed. Corners in yield surfaces of a polycrystal aggregate are shown to exist and the sharpness of the corner is shown to increase with loading. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

STRESS FIELD OF A UNIFORMLY PLASTICALLY DEFORMED CRYSTAL IN AN AGGREGATE, by T. H. Lin and S. Uchiyama. Oct. 1959, 33p. incl. diagrs. refs. (AFOSR-TN-59-1048) (AF 49(638)20) AD 233074; PB 145867 Unclassified

It is shown that the stress due to slip decreases rapidly with the distance from the slip. The region at a distance of 2 to 3 linear lengths of the cube is practically free from the effect of the slipped region. This shows that the slip in 1 crystal only affects the stresses locally and does not affect the main part of the aggregate. When the aggregate stress produces a resolved shear stress in the most favorably oriented crystal greater than its critical shear stress, this excess shear stress is relieved by slips. It is also shown that the shear stress τ_{12} , relieved due to a uniform slip in the crystal, varies with the distance from the center. For relieving the same amount of excess shear stress in the crystal, a heterogeneous slip is required.

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California U. Dept. of Engineering, Los Angeles.

ON THE OPTIMUM SYNTHESIS OF MULTIPOLE CONTROL SYSTEMS IN THE WIENER SENSE, by H. C. Hsieh and C. T. Leondes. Mar. 1959, 61p. (AFOSR-TN-59-263) (AF 49(638)438) AD 212466 Unclassified

Also published in I.R.E. Nat'l. Convention Record, Pt. 4: 18-31, 1959.

This report is concerned with obtaining the optimum system in the Wiener sense for a certain multipole system. Earlier literature has shown how to obtain the mean-square value of the error when the multipole system transfer function has been specified, but thus far no published work has shown how to solve the synthesis problem, in general, for this case. The principal reason that this problem has appeared to be impossible of analytic solution thus far for cross correlation between the inputs is based on the fact that the usual variational approach results in a set of untractable simultaneous integral equations involving many complicated cross products of the desired weighting functions and the variational functions. The synthesis

problem for the above-mentioned multipole system is first solved for the case in which there is no correlation between the inputs to the various terminals. Following this, the far more complicated case of the synthesis problem when the inputs to all the various terminals are correlated is considered. In this case, a rather unique technique is utilized to avoid the difficulties inherent in the use of the usual variational techniques. Through the technique utilized in this report, the usual set of untractable simultaneous integral equations is completely avoided, and instead, a set of ordinary algebraic equations results. The report then concludes with an illustrative example for the more complicated case of correlated inputs.

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California U. Dept. of Engineering, Los Angeles.

A PARAMETER TRACKING SERVO FOR ADAPTIVE CONTROL SYSTEMS, by M. Margolis and C. T. Leondes. Aug. 1959, 30p. incl. diagrs. table, refs. (AFOSR-TN-59-917) (AF 49(638)438) AD 229570; PB 144769 Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Also published in I.R.E. WESCON Convention Record, Pt. 4: 104-115, 1959.

Also published in I.R.E. Trans. on Automatic Control, v. AC-4: 100-111, Nov. 1959.

A general approach to the design of adaptive control systems is described. The particular systems considered are process adaptive. The dynamic characteristics of the physical process are determined by the parameter tracking servo. The parameters determined are used to program the process controller. The parameter tracking servo is a closed loop self-adjusting system with (1) the physical process, (2) the learning model, and (3) the adjusting mechanism. The learning model and the physical process are subjected to the same input signals. Their outputs are compared and the resultant error is fed to the adjusting mechanism where some function of this error is used to adjust the parameters of the learning model. The mechanism will continuously track the parameters of the physical process as they change with time. The adjusting mechanism operates on an approximation to the method of steepest descent. These equations are derived for a first order process and the overall system is analyzed. The equations describing the tracking servo's operation are both nonlinear and nonautonomous. System response as a function of input signal, gain, and error function is described analytically. Experimental results are included to demonstrate the validity of the analytic solutions. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

TECHNIQUES FOR THE OPTIMUM SYNTHESIS OF MULTIPOLE CONTROL SYSTEMS WITH RANDOM PROCESSES AS INPUTS, by H. C. Hsieh and C. T. Leondes. Sept. 1959 [39]p. incl. diagrs. (AFOSR-TN-59-1132) (AF 49(638)438) AD 230196; PB 145488
Unclassified

Presented at Nat'l. Automatic Control Conf., Dallas, Tex., Nov. 4-6, 1959.

Also published in I.R.E. Trans. on Automatic Control, v. AC-4: 212-231, Dec. 1959.

The general problem of obtaining the optimum multipole system when the inputs to the system are stationary random processes is considered. The system under investigation was linear and time invariant. The input to each terminal consists of signal and noise. The synthesis procedure was carried out under the basis that a fixed plant must be compensated in order to perform certain desired tasks. The design criterion employed was the minimum mean-square error between actual outputs and ideal outputs of the system. A set of integral equations is obtained, which is converted into algebraic equations through transformation. By solving these equations and using the method of undetermined coefficients, the transfer functions of the compensation is uniquely determined. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

ON THE PHILOSOPHY OF ADAPTIVE CONTROL FOR PROCESS ADAPTIVE SYSTEMS, by M. Margolis and C. T. Leondes. Jan. 1960, 13p. incl. diagrs. (AFOSR-TN-59-1199) (AF 49(638)438) AD 233499; PB 146376
Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Apr. 12-14, 1959.

Also published in Proc. Nat'l. Electronics Conf., v. 15: 27-33, 1959.

A very general approach to the design of process adaptive systems is described. A brief look is taken at the development of feedback control theory and practice. Process adaptive control is discussed as a logical extension of the basic concepts of feedback theory. A particular mechanism for process adaptive control is suggested. This mechanism makes use of a learning model whose form is the same as the physical process and whose parameters are continually adjusted so that the model and process behave as much alike as possible. The parameters of the model are used to set the parameters of the controller for the overall control of the system. (Contractor's abstract)

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California U. Dept. of Engineering, Los Angeles.

ON THE THEORY OF ADAPTIVE CONTROL SYSTEMS, THE LEARNING MODEL APPROACH, by M. Margolis and C. T. Leondes. Oct. 1959 [25]p. incl. diagrs. (AFOSR-TN-59-1200) (AF 49(638)438) AD 233275; PB 146736
Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 2: 556-563, 1960.

The main objective of feedback control is to maintain satisfactory performance despite adverse environmental effects. A process adaptive system is one which determines the values of the significant parameters in the physical process and used these values to program the controller according to the specified control laws. The physical process must either be indeterminate or vary widely in its dynamic characteristics as its environment changes to justify the use of a process adaptive system. The use of a process adaptive system then makes it possible to design the complete control system for a specified requirement without compromising the setting of the controller parameters for the range of dynamic characteristic variation. The learning model will determine these variations and present the exact values to the proper computing circuits for adjusting the parameters in the controller. The particular method for determining the dynamic characteristics of the physical process makes use of a model, referred to as the learning model, and a mechanism to adjust the parameters of the model. The model is a computer mechanization of the physical process with undetermined parameters.

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California U. Dept. of Engineering, Los Angeles.

EXTENDED SYNTHESIS TECHNIQUES FOR MULTIPOLE SAMPLED-DATA CONTROL SYSTEMS, by E. B. Stear and C. T. Leondes. Oct. 1959, 12p. incl. diagrs. (AFOSR-TN-59-1223) (AF 49(638)438) AD 233276
Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 12-14, 1959.

Also published in Proc. Nat'l. Electronics Conf., v. 15: 299-309, 1959.

A logical and efficient procedure for the synthesis of multipole sampled-data control systems is presented. It is assumed that the specifications on the system are stated in the time domain, and this is in fact a common situation. Furthermore, it is not assumed in the synthesis procedure presented that the specifications are stated only at the sampling instants of the system, but rather at arbitrary and necessary instants of time. II.

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addition to this, a lower bound is established for the sampling rate based on system requirements. This last exceedingly important aspect has received very little attention in the literature. (Contractor's abstract)

270

California U. Santa Barbara [Coll.] Goleta.

NUCLEAR ABSORPTION CROSS SECTIONS FOR 3.6 BEV NEUTRONS, by P. H. Barrett. Dec. 22, 1958 [9]p. incl. diagrs. table. (AFOSR-TN-59-15) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)9 and Atomic Energy Commission) AD 208596 Unclassified

Also published in Phys. Rev., v. 114: 1374-1375, June 1, 1959.

The absorption cross section for Pb, Cu, and Al were measured by means of poor geometry transmission measurements. The neutrons were produced by bombarding a 1 in. thick polyethylene target with 6.2 bev protons in the Bevatron. Neutron detection was accomplished by measuring the density of stars in nuclear emulsion. These measurements gave for the absorption cross sections for Pb, Cu, and Al 1930 ± 300 mb, 704 ± 140 mb, 430 ± 56 mb. An absorption mean free path in emulsion of $\lambda = 50 \pm 10$ cm was obtained. The source strength of the neutrons was calculated to be 0.19 neutron/steradian/proton striking the target. By comparing the multiplicity of mesons produced in nuclear interactions by the neutron beam and by protons of known energy the average energy of 3.6 ± 0.7 bev was obtained for the neutron beam. (Contractor's abstract)

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California U. Santa Barbara [Coll.] Goleta.

[NEUTRON INTERACTION STUDIES] by P. H. Barrett. Final rept. [1959] [1]p. (AFOSR-TN-59-193) (AF 49-638)9 Unclassified

The research performed on this contract was concerned with a group of nuclear emulsions which were exposed to the neutron beam of the Bevatron in order to ascertain (a) the energy spectrum of the neutrons and (b) the nuclear absorption cross section for Al, Cu, and Pb. A published version of the results is appended (see item no. 270). A new approach to determining the neutron energy by analyzing the angular distribution of the mesons produced in nuclear interactions yielded an average neutron energy value of 5 ± 2 bev.

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Cambridge U. Cavendish Lab. (Gt. Brit.).

STRUCTURAL INVESTIGATIONS, BY X-RAY DIFFRACTION METHODS, OF TRANSITION-METAL ALLOYS,

by W. H. Taylor. Technical status rept. no. 4, Jan. 1-Dec. 31, 1958, 6p. (AFOSR-TN-59-345) (AF 61(052)50) AD 264283 Unclassified

A report is presented on the progress made under this contract which involves the analysis of the structures of a number of transition-metal alloys and also the application of highly-refined techniques to 1 or more of these alloys, and to pure metals, with a view to the determination of electron distribution. The study of Fe-Al system included the discovery and description of a new phase and the re-examination and refinement of a structure previously proposed. The study on Fe_2Al_5 system shows that there are significant differences between the Al-rich and Fe-rich structures. The Mn-Al system was also reexamined in the phase-diagram between 33% and 45% Mn, for temperatures below 880°C. Two previously unknown phases were isolated, and the Hofman phase was shown to be stable only above 880°C. An x-ray fluorescence spectrometer was developed for the analysis of minute single crystals.

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Cambridge U. Cavendish Lab. (Gt. Brit.).

THE CRYSTAL STRUCTURE OF Mn_3Al_{10} , by M. A. Taylor. [1959] [10]p. incl. tables, refs. (AFOSR-TN-59-346) (AF 61(052)50) Unclassified

Also published in Acta Cryst., v. 12: 393-396, May 1959.

The crystal structure of a previously unknown metallic compound Mn_3Al_{10} , hereinafter referred to as α (AlMn), has been determined by x-ray analysis. The cell dimensions and atomic parameters of the structure and the interatomic distances between neighboring atoms are given. The structure is very similar to that of Robinson's β (AlMnSi) (Acta Cryst., v. 5: 397-403, July 1952), and comparisons between the 2 structures are made.

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Cambridge U. Cavendish Lab. (Gt. Brit.).

ON AN ANALYTIC APPROXIMATION TO THE ATOMIC SCATTERING FACTOR, by J. B. Forsyth and M. Wells. [1959] [12]p. incl. tables, refs. (AFOSR-TN-59-347) (AF 61(052)50) Unclassified

Also published in Acta Cryst., v. 12: 412-415, May 1959.

The atomic scattering factor, f , is approximated as a function of $\sin \theta / \lambda = s$. A table is presented of analytic constants using the most recently published values of the atomic scattering factor. It is shown that the scattering factors for Al^{3+} , Ca^{2+} , Mn^{2+} , and Mn^0 agree

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with those by Freeman. Interpolations for the scattering factor values for V^{2+} , Cr^{2+} , Co^{2+} , and Ni^{2+} are made, much because of the availability of wave functions with exchange for these elements. A table is proposed for new scattering factor values from the work reported in this paper, and a possible explanation for their non-compactibility with previous values made.

275

[Cambridge U.] Cavendish Lab. (Gt. Brit.).

[MAGNETIC EFFECTS OF TRANSITION IMPURITIES IN ALUMINUM] Effets magnétiques d'impuretés de transition dans l'aluminium, by M. A. Taylor, J. P. Burger, and J. Wucher. [1959] [2]p. incl. diagrs. table. (AFOSR-3816) [AF 61(052)50] Unclassified

Also published in Jour. Phys. et Radium (Paris), v. 20: 829-830, Oct. 1959.

Magnetic measurements were made on aluminum-rich transition-metal alloys. Susceptibilities over a range of temperatures between 90° and 290°K were determined for weak concentrations of V, Cr, and Mn in Al. The results are tabulated. Measurements of the Hall coefficient for aluminum alloys are included.

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Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

DISPERSION RELATION PREDICTIONS FOR π -p SCATTERING, by T. D. Spearman. Oct. 1959 [5]p. incl. diagrs. refs. (Scientific note no. 1) (AFOSR-TN-59-1313) (AF 61(052)233) AD 232058; PB 145682 Unclassified

The dispersion relations for forward elastic π -p scattering are used to calculate the real parts of the forward scattering amplitude. It is found that using more accurate experimental data, the discrepancy observed by Puppi and Stanghellini can be resolved. A more precise value for the renormalized π , N coupling constant is predicted. (Contractor's abstract)

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Cambridge U. Dept. of Applied Mathematics and Theoretical Physics (Gt. Brit.).

LOW ENERGY PION PHENOMENA, by J. Hamilton and W. S. Woolecock. Oct. 1959, 33p. incl. diagrs. refs. (Scientific note no. 2) (AFOSR-TN-59-1314) (AF 61-052)233) AD 234215; PB 146739 Unclassified

Also published in Phys. Rev., v. 118: 291-299, Apr. 1, 1960.

The relation between low energy pion-nucleon scattering and pion photoproduction is examined. Correct extrapolation to threshold of both the π^+ and π^- photoproduction data gives agreement with theory. A recent new method for analyzing the scattering data is applied, giving $a_1 = 0.178$, $a_3 = 0.587$, and reasonable agreement

with the Panofsky ratio $P = 1.5$ is obtained. An inner Coulomb correction to the scattering data helps to improve this agreement. The possibility of detecting a $\pi - \pi$ interaction by low energy pion scattering is examined. A new dispersion relation connects the s- and p-wave phase shifts at low energies; this relation excludes some well known sets of phase shift curves. (Contractor's abstract)

278

Cambridge U. Medical Research Council (Gt. Brit.).

RESEARCH ON REVERSIBLE PERCEPTION OF SPEECH SOUNDS, by R. M. Warren. Final rept. Sept. 30, 1959, 25p. incl. tables. (AFOSR-TR-59-148) (AF 61-052)184) AD 232057; PB 146098 Unclassified

If a loop of tape containing a single word is played over and over, the word heard seems to shift suddenly to another word. After a while another illusory change is experienced with this unchanging stimulus, sometimes back to the 1st form and sometimes to a 3rd form. These transitions continue at frequent intervals as long as the tape is played. This verbal transformation effect was studied to determine the factors governing the rate of transitions and the variety of the different forms heard. Various repeating verbal stimuli were presented to 18 naval ratings, each stimulus being played for 3 min. The principal findings are: (1) verbal transformations were obtained with all the repeating experimental stimuli, varying in complexity from 2 speech sounds to complete sentences; (2) repeating speech made indistinct by masking noise produced fewer transitions and fewer different forms than the same recording heard clearly; (3) when loudness of speech was sufficient to incur clarity, further increase in loudness seemed to have little effect on verbal transformations; (4) repeating unfamiliar words tended to be distorted in the first (and subsequent) forms into familiar words; (5) tapes of the same word, each with silent intervals of different length between repetitions were employed; and (6) previous stimulation by a word of closely related phonetic structure was followed (even after a few days) by responses related to the previous word. (Contractor's abstract)

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Cambridge U. Psychological Lab. (Gt. Brit.).

THE EFFECT OF MEPROBAMATE ON AUDITORY DISCRIMINATION, DELAYED RESPONSE AND TIME INTERVAL ESTIMATION IN RHESUS MONKEYS, by C. G. Gross, J. M. Oxbury, and L. Weiskrantz. [1959] [1]p. [AF 61-052)185] Unclassified

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Published in Proc. First Internat'l. Cong. of Neuro-psychopharmacology, Rome (Italy) (Sept. 1958), Amsterdam, Elsevier, 1959, p. 318.

Injections of meprobamate into Rhesus monkeys resulted in slight to severe ataxia depending upon the dosage, but no taming effect was observed. Each animal was tested 5 times after drug injection and 5 times as controls. All the animals showed a deficit on the auditory discrimination. No animal showed a deficit on the delayed response problem. In fact, 1 animal improved its delayed response performance after the injection. The drug appeared to have the effect of delaying the timing sense in the animals. It is concluded that tranquilizing drugs block incoming sensory information. The fact that certain electrophysiological data have been interpreted as evidence that meprobamate selectively affects thalamic nuclei may also be relevant to the finding of an auditory deficit.

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Cambridge U. Press, New York.

JOURNAL OF FLUID MECHANICS, ed. by G. K. Batchelor. Jan. 1959-Dec. 1959. (MIPR-680-59-3 and Nonr-254800) Unclassified

This international periodical covers theoretical and experimental research investigations of all aspects of fluid mechanics.

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Carnegie Inst. of Tech. Dept. of Civil Engineering, Pittsburgh, Pa.

FRACTURE ARREST BY RIVETED STIFFENERS, by J. P. Roniualdi and P. H. Sanders. [1959] [12]p. incl. diagrs. table, refs. (AF 49(638)237) Unclassified

Published in Proc. Fourth Midwestern Conf. on Solid Mech., Texas U., Austin (Sept. 9-11. 1959), Austin, Texas U. Press, 1959, p. 74-90.

The total stress intensity factor at the tip of a crack is theoretically determined and good agreement is obtained between calculated values and those determined by strain gages. The kinetic energy of the material surrounding a running crack is found to be an important factor affecting the max rivet force at fracture arrest. Tests show that when a running crack is stopped by a riveted stiffener the max rivet force can be as much as 25% greater than that which would be obtained with a slowly moving crack.

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Carnegie Inst. of Tech. Dept. of Mathematics, Pittsburgh, Pa.

ON A CLASS OF NON-LINEAR SECOND-ORDER DIF-

FERENTIAL EQUATIONS, by Z. Nehari. Apr. 1959 [32]p. (Technical rept. no. 25) (AFOSR-TN-59-179) (AF 49(638)227) AD 211319; PB 14004E Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 101-123, Apr. 1960.

Oscillatory properties are outlined solutions of the differential equation (a) $y'' + y F(y^2, x) = 0$, $y = y(x)$, where $F(t, x) > 0$ for $x > 0$, $t > 0$, and $t^{-\epsilon} F(t, x)$ is an increasing function of t for some positive ϵ and constant x . A number of conditions are derived which are either necessary or sufficient for the existence of a non-oscillatory solution of (a). In the discussion, a central role is

played by the variational problem $\int_a^b [y'^2 - G(y^2, x)] dx =$

min under the side conditions $\int_a^b y'^2 dx = \int_a^b y^2 F(y^2, x) dx$,

$y(a) = y'(b) = 0$, $y \in D^1[a, b]$, $y \neq 0$, where $G(tx) = \int_0^t$

$F(s, x) ds$. The problem is shown to have a solution which satisfies equation (a), and it therefore becomes possible to investigate the behavior of the solutions of (a) by means of variational techniques. (Contractor's abstract)

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Carnegie Inst. of Tech. Dept. of Mathematics, Pittsburgh, Pa.

SOME EIGENVALUE ESTIMATES, by Z. Nehari. Apr. 1959 [13]p. (Technical rept. no. 26) (AFOSR-TN-59-331) (AF 49(638)227) AD 213652; PB 140533 Unclassified

Also published in Jour. Anal. Math. (Jerusalem), v. 7: 79-88, 1959.

The following 2 inequalities are proved: (1) If $p(x)$ is non-negative, monotonic and L^1 in $[a, b]$, and λ denotes the lowest eigenvalue of the system $y'' + \lambda p(x)y = 0$,

$y(a) = y(b) = 0$, then $\lambda^{1/2} \int_a^b \sqrt{p(x)} dx > \frac{\pi}{2}$. (2) If, under

the same conditions for $p(x)$, Λ is the lowest eigenvalue of $y'' - \Lambda p(x)y = 0$, $y(a) = y'(a) = y(b) = y'(b) = 0$, then

$\Lambda^{1/4} \int_a^b \sqrt[4]{p(x)} dx > k \sim 1.88$, where k is the smallest

positive root of $\cos k \cosh k + 1 = 0$. Both constants are best possible. The inequalities are used to derive oscillation criteria for the equations $y'' + p(x)y = 0$ and $y'' - p(x)y = 0$, respectively. (Contractor's abstract)

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Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON A CLASS OF NONLINEAR INTEGRAL EQUATIONS,
by Z. Nehari. May 1959 [14]p. (Technical rept. no. 27)
(AFOSR-TN-59-425) (AF 49(638)227) AD 214775;
PB 142153 Unclassified

Also published in Math. Zeitschr., v. 72: 175-183,
1959.

The Hammerstein-type nonlinear integral equation

$$y(x) = \int_a^b K(x,t)y(t)F(y^2,t)dt$$
 is shown to possess a continuous solution in $[a,b]$ under the following hypotheses:

(1) $K(x,t)$ is a continuous, symmetric, positive-definite kernel; (2) the function $F(u,x)$ is, for $u \in (0, \infty)$ and $x \in [a,b]$, positive and continuous; and (3) there exists a positive ϵ such that $u_1^{-\epsilon} F(u_1,x) < u_2^{-\epsilon} F(u_2,x)$ if

$0 < u_1 < u_2 < \infty$. The existence of a solution of the more general equation $y(x) = \int_a^b K(x,t)y(t)[p(t) + F(y^2,t)]dt$

is proved under the assumption that $p(x)$ is continuous and non-negative in $[a,b]$, and that the lowest eigenvalue Λ of the linear integral equation

$$v(x) = \Lambda \int_a^b k(x,t)v(t)dt$$
 is larger than unity. (Contractor's abstract)

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Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

BOUNDS FOR THE EIGENVALUES OF SOME VIBRATING SYSTEMS, by D. Banks. June 1959, 53p. incl. refs. (Technical rept. no. 28) (AFOSR-TN-59-508) (AF 49(638)227) AD 216273 Unclassified

Also published in Pacific Jour. Math., v. 10: 439-474, 1960.

Lower bounds for the smallest eigenvalue λ_1 of the system $u'' + \lambda p(x)u = 0$, $u(0) = u(1) = 0$, where $p(x) \geq 0$, are found under 3 assumptions: (1) if $p(x)$ is monotone, (2) if $p(x)$ is convex with respect to the x -axis, and (3) if $p(x)$ is concave. A geometric characterization of the density function which gives the lower bound for the higher eigenvalues is obtained in each of the 3 cases. Some of the results for the lowest eigenvalue are extended to the case of a more general Sturm-Liouville system. A sharp lower bound for the lowest eigenvalue of a rod with clamped ends is found when the density is given by a concave function. For monotone and convex density functions the form of the function which gives a sharp lower bound is obtained.

Sharp lower bounds for the lowest eigenvalue of a membrane with fixed edges are found for a bounded density function, and for a concave density function over a convex domain. (Contractor's abstract)

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Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON THE SCATTERING OF WAVES BY A DISK, by A. E. Heins and R. C. MacCamy. June 1959 [20]p. (Technical rept. no. 29) (AFOSR-TN-59-721) (AF 49(638)227) AD 225546; PB 143773 Unclassified

Also published in Zeitschr. Angew. Math. and Phys., v. 11: 249-264, 1960.

The scattering of sound waves by a circular disk of so-called soft material is analyzed. The appropriate boundary value problem is the determination of a function

$$U(r, \theta, z) \text{ satisfying the equation, } U_{rr} + \frac{1}{r} U_r + \frac{1}{r^2} U_{\theta\theta} +$$

$$U_{zz} + k^2 U = 0 \text{ with the condition } U(r, \theta, 0) = 0 \text{ for } r < 1.$$

In addition $U(r, \theta, z)$ is to be made up of an incident field

$U^0(r, \theta, z)$, which is prescribed, and a term $U^s(r, \theta, z)$ satisfying a radiation condition at infinity. One method of solution is to formulate the problem as an integral equation. This method is outlined, and some simple calculations are presented for the case in which $U^0(r, \theta, z)$ represents a plane wave of arbitrary angle of incidence. An approximate formula is included for the scattering cross section, as a function of angle of incidence, when the wave number k is small. (Contractor's abstract)

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Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

ON THE SCATTERING OF WATER WAVES BY A CIRCULAR DISK, by R. C. MacCamy. Dec. 1959 [26]p. incl. refs. (Technical rept. no. 30) (AFOSR-TN-59-1261) (AF 49(638)227) AD 230355; PB 145323 Unclassified

The boundary-value problem describing the diffraction of 2-dimensional water waves by a dock of finite width has not as yet been solved in explicit fashion. It has however received considerable attention. The general problem of diffraction by surface obstacles was investigated thoroughly by John and later by Peters and Stoker. An existence proof for the finite dock problem, using the calculus of variations was given by Rubin. Finally it was shown by the author that the integral equation approach can be greatly simplified for the dock

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problem. It is the purpose of this paper to point out that the earlier results can be extended to the 3-dimensional problem of diffraction by a circular disk.

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Carnegie Inst. of Tech. Dept. of Mathematics,
Pittsburgh, Pa.

CHARACTERISTIC VALUES ASSOCIATED WITH A CLASS OF NONLINEAR SECOND-ORDER DIFFERENTIAL EQUATIONS, by Z. Nehari. Dec. 1959, 45p. (Technical rept. no. 31) (AFOSR-TN-59-1262) (AF 49-638)227 AD 231156; PB 145492 Unclassified

Also published in Acta Math., v. 105: 141-175, 1961.

The purpose of this study is to investigate the properties of those solutions $y(x)$ of $y'' + yF(y^2, x) = 0$, or, more generally, $y'' + p(x)y + yF(y^2, x) = 0$, which satisfy the boundary conditions $y(a) = y(b) = 0$. It is shown that there exists a countable set of such solutions, and that these solutions — which may be characterized by the number of their zeros in (a, b) — correspond to the stationary values of a certain functional. The latter are termed characteristic values of the problem, and their asymptotic behavior is studied.

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Carnegie Inst. of Tech. [Dept. of Mathematics]
Pittsburgh, Pa.

POSTULATES FOR COMMUTATIVE GROUPS, by M. Sholander. [1959] [3]p. [AF 49(638)227] Unclassified

Published in Amer. Math. Monthly, v. 93-95, Feb. 1959.

Two 1-postulate systems which characterize commutative groups are given. The more striking of the results asserts that a system closed under a binary operation $x \cdot y$ satisfying the identity $y = x - [(x \cdot z) - (y \cdot z)]$ is an Abelian group. (Math. Rev. abstract)

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Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

OXIDATION OF METALS, by W. W. Smeltzer and L. H. Everett. May 15, 1959 [6]p. incl. tables, refs. (AFOSR-TN-59-306) (AF 18(600)1572) AD 213090 Unclassified

Also published in Indus. and Eng. Chem., v. 51: 406-411, Mar. 1959.

A review is presented of publications related to the prevention of metal oxidation. Studies are reviewed of

oxidation kinetics, diffusion coefficients, and structural and compositional properties of oxide layers. Publications are cited giving critical assessments of oxidation theories with emphasis placed on ionic transport, oxide plasticity, and epitaxial properties. There are 196 foreign and domestic references cited covering a time period from 1956 to 1958.

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Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

THE KINETICS OF WUSTITE SCALE FORMATION ON IRON, by W. W. Smeltzer. [1959] [7]p. incl. illus. diagrs. table, refs. (AFOSR-TN-59-640) (AF 18(600)-1572) AD 247825 Unclassified

Also published in Acta Metall., v. 8: 377-383, June 1960.

The kinetics of scale formation on iron in carbon dioxide atm have been determined in the temperature range 600°-1100°C by a thermogravimetric technique. The scale constituents were identified by means of x-ray and microscopic examinations. The oxidation rates obeyed linear and parabolic time laws for short and long exposures, respectively. Linear scaling was determined by the rate of incorporation of chemisorbed oxygen into the wustite lattice at temperatures lower than 910°C, and by dissociation of carbon dioxide and incorporation of oxygen into wustite at higher temperatures. The theoretical temperature coefficient of the parabolic rational rate constant for wustite formation was evaluated over the temperature range of its stability. Results from the literature on parabolic oxidation of iron in oxygen were in good agreement with the theoretical evaluation, whereas the results obtained for oxidation in carbon dioxide were of smaller magnitude above the Curie temperature of iron. This behavior was explained by the consideration that the chemical activity of oxygen in wustite at the oxide gas interface was insufficient for equilibration of wustite with magnetite. (Contractor's abstract)

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Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

FIELD EMISSION MICROSCOPY OF METAL CRYSTAL NUCLEATION, by K. L. Moazed and G. M. Pound. Final rept. Sept. 15, 1959, 110p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-131) (AF 18(600)1572) AD 225717; PB 143829 Unclassified

Techniques were developed for a field emission microscopic investigation of the heterogeneous nucleation of metal vapors on metallic substrates. Quantitative measurements were made for the nucleation of silver on tungsten. Nucleation was observed to occur when the population of adsorbed silver atoms reached a critical value. There were definite preferred sites on the

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substrate surface where nucleation occurred. An extension of the present theory of nucleation was made so that the present experimental case could be treated. Qualitative observations on the mobility of silver on tungsten showed the mobility of the silver deposit to be anisotropic on the emitter tip. Qualitative observations were also made on the evaporation and desorption of silver from a tungsten emitter tip, and the adsorption and desorption of residual gases on the emitter tip. (Contractor's abstract)

293

Carnegie Inst. of Tech. Metals Research Lab.,
Pittsburgh, Pa.

DISLOCATION DYNAMICS AT LOW TEMPERATURES,
by J. Lothe and J. P. Hirth. [1959] [8]p. incl. diagrs.
refs. (AFOSR-3394) (AF 49(638)551) Unclassified

Published in Phys. Rev., v. 115: 543-550, Aug. 1, 1959.

A model for low-temperature dislocation motion is developed using the concept of nucleation and growth of kinks in dislocations lying in Peierls potential troughs. The model is compared with existing experimental data. (Contractor's abstract)

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Catholic U. of America. [Dept. of Chemistry]
Washington, D. C.

THE PROBLEMS ENCOUNTERED IN CONSTRUCTING
POTENTIAL ENERGY SURFACES (Abstract), by V.
Griffing. [1959] [1]p. (AF 18(600)1537) Unclassified

Presented at Symposium on Reaction Rate Theory,
Wisconsin U., Madison, Mar. 30-Apr. 1, 1959.

It may be expected from present developments in the field of molecular quantum mechanics that reliable potential energy surfaces can be calculated by M. O. method in the next few years. However, even when the computational difficulties are solved, the calculation of a multi-dimensional surface will remain an enormous undertaking. Thus the best that can be hoped for in the near future are calculations over a limited range of configuration space and this for only a few typical systems. In addition, it is shown that the interaction between hydrogen atoms are atypical. Since the only extensive surfaces that have been calculated quantum mechanically in the past are these systems it is possible that some of the difficulties in present rate theory can be attributed to an intuitive generalization of these systems. Even after reliable and typical surfaces are calculated the interpretation of these surfaces in terms of the dynamical problems concerning colliding molecules and which are in vibrational and rotational excited states still present many puzzles. (Contractor's abstract)

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Catholic U. of America. [Dept. of Chemistry]
Washington, D. C.

THEORY OF REACTION RATES FROM A COLLISIONAL
VIEWPOINT (Abstract), by K. F. Herzfeld and V.
Griffing. [1959] [1]p. (AF 18(600)1537) Unclassified

Presented at Symposium on Reaction Rate Theory,
Wisconsin U., Madison, Mar. 30-Apr. 1, 1959.

The current theory of the monomolecular decomposition of a polyatomic molecule assumes a two-step process, energy supply by collision and subsequent break up. The relative rate of these steps can be found from the pressure at which the transition between monomolecular (break up) and bimolecular (energy supply) mechanism occurs. From the experimental data it is concluded that a high efficiency of energy supply exists. In the simpler case of dissociation of a diatomic molecule, the present picture is that of transfer of sufficient kinetic energy by collision to the vibration so that, after about half a period of vibration, the molecule can fly apart without further quantum jump. In the reverse reaction, a triple collision between two atoms and a third partner is needed, the partner carrying off the excess energy. The efficiency of the energy transfer and of the triple collision must be equal, from equilibrium considerations. Experiments on recombination (bromine, iodine, oxygen, nitrogen) seem to show a high efficiency, again in contradiction to the type of calculation which has been successful in evaluating ultrasonic results, and which gives efficiencies below 1%. Furthermore, experimental results seem to indicate cooperation of rotational motion, which points to the importance of other than head-on collision. (Contractor's abstract)

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Catholic U. of America. Dept. of Physics,
Washington, D. C.

[ABSORPTION SPECTRA OF POLYATOMIC MOLECULES] by K. F. Herzfeld. Final rept. Oct. 20, 1959,
3p. (AFOSR-TR-59-156) (AF 18(600)890)

Unclassified

The work on this project was broken down into 4 parts, the 1st of which was the problem of spectrograph slit illumination. The work is reported in detail in the following Master's thesis: (1) The Optimum Slit Width of a Spectrograph, by Brother M. Guttman. (2) Central Intensity of a Spectral Line under Approximate Experimental Conditions, by A. E. Cahill. (3) An Experimental Study of Off-Axis Coherent Illumination of a Spectrograph, by D. W. Harkabus. (4) The Half-width of a Spectral Line as a Function of Slit Width for Various Widths of Entrance Slit under Coherent, Non-coherent or Intermediate Modes of Illumination, by D. F. Ressler. The 2nd phase concerns itself with the work in Raman Spectra and the more recent work is reported in the following Master's thesis: (1) Raman Spectra of Pure Liquids and

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Solution of Pure Liquids, by D. A. Nordling. (2) Photoionization and Photofluorescence in P-diiodobenzene, by E. D. Hall. (3) Liquid Filters for the Raman Spectra, by Sister M. M. Boyle. In the 3rd phase the speed of the instrument was improved to help approach theoretical resolution and was reported in the following: Testing of East Raman Spectrograph, by J. E. Barry. The final work was concerned with the measurement of HCl. Results indicated that the brightest discharge is at about .1mm of mercury. Because slight impurities of CO tend to change the nature of the discharge, a method of purifying HCl was also devised.

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Catholic U. of America. Dept. of Physics,
Washington, D. C.

LINEARITY AND MINIMUM ENTROPY PRODUCTION,
by P. H. E. Meijer. Final rept. Feb. 2, 1959 [14]p.
incl. refs. (Technical note no. 3M-1) (AFOSR-TR-59-
178) (AF 18(603)120) Unclassified

The purpose of this paper is to show that the minimum entropy production principle actually does hold in a limited range outside what is conventionally called linear irreversible thermodynamics. It is concluded that the expression "linear" refers either to the Onsager relations between fluxes and forces or it refers to the Fokker-Planck or Master equation. Linear processes in the Onsager sense form a much more restrictive class than the linear processes in the Fokker-Planck equation. The minimum entropy production theorem, i.e. its equivalence for the steady state holds for the linear processes in the Fokker-Planck sense.

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Catholic U. of America. Dept. of Physics,
Washington, D. C.

LINEARITY AND MINIMUM ENTROPY PRODUCTION,
by P. H. E. Meijer. Feb. 2, 1959, 14p. incl. refs.
(Technical note no. 3M-1) (AFOSR-TN-59-152)
(AF 49(638)452) AD 262974 Unclassified

The application of the entropy production principle is discussed in terms of linear irreversible thermodynamics. The description of these processes is based on a set of linear, master equations. The most important aspect of these equations (Fokker-Planck) is that they are 1st-order differential equations in time and are asymmetric in character. Conclusions are presented for both internal and external systems.

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Catholic U. of America. Dept. of Physics,
Washington, D. C.

MEAN FREE PATH IN DENSE GASES AND LIQUIDS,

by P. H. E. Meijer and J. I. Bowen. Mar. 29, 1959
[6]p. incl. diagrs. (AFOSR-TN-59-694) (AF 49(638)452)
Unclassified

A simple expression for the mean free path in a fluid is derived. The derivation used is strictly speaking only correct for hard sphere atoms. It is shown that low densities give the usual exponential distribution and that the high density limit, in which the atoms are supposed to be boxed in, gives rise to a mean free path equal to the reduced length of the box. Under the assumption that it is proper to make use of the general properties of the 2 particle correlation function some tentative conclusions are made about the behavior of the mean free path as a function of the density. (Contractor's abstract)

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Chicago Development Corp., Riverdale, Md.

ELECTROLYTE EQUILIBRIA AND ELECTRODE BEHAVIOR IN THE SOLUBLE ANODE TITANIUM PROCESS, by R. S. Dean, W. W. Gullett and others. [Jan. 12, 1959] [26]p. incl. refs. [Rept. no. 2] (Bound with its AD 217781) [AF 18(600)1458] Unclassified

Crystal intergrowths of Mn-Ti alloy, with an average analysis of 8.3% Mn and of V-Ti alloy with an average analysis of 1.35% V, were produced on an experimental basis by the soluble anode process. The electrolyte was a single-phase liquid at 800° to 850°C consisting of NaCl in which was dissolved Ti as lower chlorides with an average valence of 2.3 to 2.5 and 0.1 to 0.5% metallic sodium. Such a bath, unlike other halide baths does not dissolve metal oxides so that complete refining from O was possible. The anode material in the case of the 8% Mn alloy was sheet clipping of scrap alloy. In the case of the 1 to 1.5% V alloy, the anode material was turnings of an arc-melted 5% V alloy made from scrap Ti sponge and ferrovandium. (ASTIA abstract)

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Chicago U., Ill.

SOME RESEARCH ON THE NATURE OF THE ACTION POTENTIAL IN NERVE, by R. J. Moon and D. A. Eggen. [Final rept.] Oct. 1959, 53p. incl. diagrs. refs. (AFOSR-TR-59-153) (AF 18(600)1482) AD 249549 Unclassified

This research was designed to investigate the details of the behavior of the action potential in nerve. In order to accomplish this, a gated microspectrophotometer which could be synchronized with the nerve-stimulating pulse and a gated scanning x-ray microscope similarly synchronized and phased were developed. It is concluded that the following new tools and approaches are now available for the study of nervous activity. (1) A gated microspectrophotometer for the study of time sequence of chemical events that occur during nervo-

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activity. (2) The utilization of the 7.16μ absorption peak for the examination of polarization changes that occur in nerve during the passage of the action potential. (3) The scanning x-ray microscope and its pulse sorter viewing system provides a means of determining the time change of the spatial distribution of sodium, potassium and calcium in axon during activity.

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Chicago U. Chicago Midway Labs., Ill.

RECOMBINATION PROCESSES IN p-TYPE INDIUM ANTIMONIDE, by R. N. Zitter, A. J. Strauss, and A. E. Attard. [1959] [8]p. incl. diagrs. refs. [AF 18(603)9] Unclassified

Published in Phys. Rev., v. 115: 266-273, July 15, 1959.

Photoelectromagnetic and photoconductive lifetimes have been measured from 77° to 300°K in monocrystalline p-type indium antimonide of net acceptor concentration ranging from less than 10^{15} cm^{-3} to 10^{18} cm^{-3} . It is concluded that at the lower temperatures, excess electrons are trapped in immobile states in the forbidden band and that the trap concentration is the same in all samples, regardless of net acceptor concentration. At intermediate temperatures, trapping becomes negligible but recombination continues to take place through states in the forbidden gap; there is some reason to believe that in this temperature region lifetimes are determined by more than one level of forbidden-band states. At still higher temperatures, where the samples are intrinsic, the lifetime data are consistent with the hypothesis of a direct interband Auger recombination process.

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Chicago U. Chicago Midway Labs., Ill.

OPTICAL ABSORPTION IN PURE SINGLE CRYSTAL IN Sb AT 298° AND 78°K , by S. W. Kurnick and J. M. Powell. [1959] [8]p. incl. illus. diagrs. table, refs. [AF 18(603)9] Unclassified

Published in Phys. Rev., v. 116: 597-604, Nov. 1, 1959.

The absorption spectra of single crystal homogeneous InSb were measured in the spectra range 5 to 10 microns at temperatures of 78°K and 298°K . Primary emphasis was placed on the precise determination of absorption coefficients less than 400 cm^{-1} . Absorption spectra were measured in many samples over the following range of impurity concentrations. Net impurity concentrations, expressed in atoms cm^{-3} , ranged from 5×10^{15} to 9.5×10^{16} in p-type samples, and from 2×10^{15} to 3×10^{17} in n-type samples, as determined from Hall coefficients measured at 78°K . In general, the spectral range covered included regions where the ab-

sorption was dominated by either free-carrier absorption or valence-conduction band transitions. Free-carrier absorption in p-type InSb indicates a simple valence-band structure about $k = 0$, consisting of light and heavy hole bands. Free-carrier cross sections at

298°K are $\sigma_p = 8.65 \times 10^{-16}\text{ cm}^2$ per hole and $\sigma_n = 0.23 \times$

10^{-16} cm^2 per electron (at 9μ). Whereas the free hole absorption coefficient is roughly independent of wavelength, the free electron absorption σ_n varies as

λ^2 and agrees with the classical Zener-Drude model. The main absorption edge at both temperatures may be extended to lower absorption coefficients α by subtracting the extrapolated free-carrier absorption coefficients α_c . The resultant band edge in $(\alpha - \alpha_c)$ values when plotted against photoenergy ($h\nu$) fits a straight line. The slopes of these band edges increase at the lower temperature and decrease (either at 78° or 298°K) as the acceptor concentration in the optical sample increases. Various models previously proposed are compared with the experimental results. (Contractor's abstract)

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Chicago U. Committee on Mathematical Biology, Ill.

NOTE ON THE FUSION FREQUENCY FOR STIMULI OF ALTERNATING DURATION, by H. D. Landahl. [1959] [5]p. incl. diagr. (AFOSR-TN-59-374) (AF 49(638)414) AD 213856 Unclassified

Also published in Bull. Math. Biophys., v. 21: 283-287, Sept. 1959.

The case of alternating stimulus patterns of moderately high intensity is considered in terms of the 2 factor theory model (Landahl, Bull. Math. Biophys., v. 19: 157-162, 1957). If both of the alternating patterns have the same light-dark ratio, then the relation between the period of the longer and the period of the shorter pattern at the critical flicker frequency is independent of the light-dark ratio and is given by a dimensionless expression which is roughly in agreement with data in which the light-dark ratio is one. (Contractor's abstract)

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Chicago U. Committee on Mathematical Biology, Ill.

AN APPROACH TO COMPUTERS THAT PERCEIVE, LEARN, AND REASON, by P. H. Greene. [1959] [6]p. incl. refs. (AFOSR-TN-59-375) (AF 49(638)414) AD 213855 Unclassified

Also published in Proc. Western Joint Computer Conf., San Francisco, Calif. (Mar. 3-5, 1959), New York, Inst. of Radio Engineers, v. 15: 181-186, 1959.

A discussion is given of some of the problems which are estimated to be central to the designing of machines that

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can in some sense be said to perceive, think, learn, make reasonable influences, or learn to perform acts of skill. Basic to the problem is the need to embody complex patterns in their entirety for presentation to the computer rather than discursive codes that utilize a one-dimensional sort of language. Thus a need for more than the principles of abstraction and association is advocated. What is desired is the presentation nature of the symbolism of the machine, involving the ability to perceive patterns too complex to be communicated verbally and the ability to acquire skills which are not able to be programmed discursively for the machine. The specific techniques which now exist for dealing with the problem of reasonable inference and inductive judgment, but which have not been considered in connection with computers and control mechanisms, are given.

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Chicago U. Committee on Mathematical Biology, Ill.

MATHEMATICAL BIOPHYSICS ON COLOR VISION.
III. COLOR CONSTANCY, by H. D. Landahl. Aug. 1, 1959 [8]p. incl. diagrs. (AFOSR-TN-59-904) (AF 49-638)414 AD 230021 Unclassified

Also published in Bull. Math. Biophys., v. 21: 395-402, 1959.

A mechanism is presented which can account for certain aspects of the phenomena of color constancy. The mechanism involves interaction between a given region and the remaining field. Each region is represented by a color center having the structure previously introduced (Landahl, Bull. Math. Biophys., v. 14: 317-325, 1952) to account for a number of phenomena of color vision. The trichromatic, symmetric mechanism is introduced for simplicity. The interaction is such that collaterals from each of the primaries representing the background send elements to each of the centers corresponding to the primaries representing the spot. However, the collaterals impinging upon unlike centers are excitatory while the collaterals impinging on like centers, corresponding to the same primary colors, are inhibitory. With proper choice of coefficients, the result is that for small changes in illumination, the resulting apparent color is unchanged. However, for greater changes in the color of the illumination, there results a distortion of the apparent color. A number of examples are illustrated numerically. (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

THE LAW OF THE ITERATED LOGARITHM FOR LACUNARY TRIGONOMETRIC SERIES, by M. Weiss. [1959] [26]p. (AF 18(600)1111) Unclassified

Published in Trans. Amer. Math. Soc., v. 91: 444-469, June 1959.

The purpose of this paper is to prove the following theorem: Let $S(x) = \sum_{k=0}^{\infty} (a_k \cos n_k x + b_k \sin n_k x)$ be a lacunary trigonometric series, that is to say, one such that

$$n_{k+1}/n_k > q > 1 \text{ for all } k. \text{ } B_N \text{ is written } B_N = (1/2 \sum_{k=1}^N (a_k^2 + b_k^2))^{1/2}, \text{ } M_N \text{ as } M_N = \max_{1 \leq k \leq N} (a_k^2 + b_k^2)^{1/2}$$

$$\text{and } S_N(x) = \sum_{k=1}^N (a_k \cos n_k x + b_k \sin n_k x). \text{ If for } N \rightarrow \infty, B_N \rightarrow \infty \text{ and } M_N = O \left(\frac{B_N}{(\log \log B_N)^{1/2}} \right), \text{ then for almost}$$

$$\text{all } x \limsup_{N \rightarrow \infty} \frac{S_N(x)}{(2B_N^2 \log \log B_N)^{1/2}} = 1.$$

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Chicago U. [Dept. of Mathematics] Ill.

ON HARDY-LITTLEWOOD SERIES, by M. Weiss. [1959] [10]p. (AF 18(600)1111) Unclassified

Published in Trans. Amer. Math. Soc., v. 91: 470-479, June 1959.

The behavior of the series $\sum_{i=1}^{\infty} n_i^{-1/2} \exp(i\beta n \log n + i\alpha \Theta)$

and $\sum_{i=1}^{\infty} n_i^{-1/2} (\log n_i)^{-1/2} \exp(i\beta n \log n + i\alpha \Theta)$ is discussed. β is real and nonzero. The results concerning

$S_N(\Theta)$ are $\limsup_{N \rightarrow \infty} S_N(\Theta) / (\log N \log \log \log N)^{1/2} = 1$ for

nearly all Θ , and Θ representing a variable contingent on a measurable whole, given the bidimensional distribution of $S_N(\Theta) / (1/2 \log N)^{1/2}$ tends toward the Gauss distribution.

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Chicago U. [Dept. of Mathematics] Ill.

TWO THEOREMS CONCERNING CONVERGENCE OF FOURIER SERIES, by S.-I. Izumi. [1959] [11]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1111 and National Science Foundation) Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 744-754, Oct. 1959.

Let f be an integrable function of period 2π , and let $\sigma_h(x) = f(x+h) + f(x-h) - 2f(x)$. The hypothesis that $\int_0^h \sigma_h(t) dt = o(h)$ as $h \rightarrow 0$ in the Lebesgue criterion for the

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convergence of the Fourier series for f at x to s , is replaced by $\int_0^h \phi(x(t) - \phi(x(t+h))) dt = O(h)$ as $h \rightarrow 0$. The conclusion is again that of convergence at x , but not necessarily to s . (Math. Rev. abstract)

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Chicago U. Dept. of Mathematics, Ill.

THE H_p -PROBLEM AND THE STRUCTURE OF H_p -GROUPS, by D. R. Hughes and J. G. Thompson.
Jan. 1959, 11p. (AFOSR-TN-59-26) (AF 18(600)1383)
AD 208869 Unclassified

Also published in Pacific Jour. Math., v. 9: 1097-1101, 1959.

Let G be a group, p a prime, and $H_p(G)$ the subgroup of G generated by the elements of G which do not have order p . For the case where G is finite and not a p -group, the following is proved to be true: $H_p(G) = 1$, $H_p(G) = G$, or $[G:H_p(G)] = p$. A precise description is given for the structure of G when $[G:H_p(G)] = p$.

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Chicago U. Dept. of Mathematics, Ill.

FINITE GROUPS WITH FIXED-POINT-FREE AUTOMORPHISMS OF PRIME ORDER, by J. G. Thompson.
Feb. 1959, 8p. incl. refs. (AFOSR-TN-59-180)
(AF 18(600)1383) AD 211320 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 578-580, Apr. 1959.

Using the following theorem, N , the normal subgroup of G , is shown to be nilpotent. Let G be a finite group with a p -Sylow subgroup P , p an odd prime, and let c be a group of automorphisms of G which leaves P invariant. Suppose for every φ -invariant normal subgroup Q of P , elements of order prime to p which normalize Q also centralize Q . Then G possesses a normal p -complement. The maximal subgroups of a finite group are discussed.

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Chicago U. Dept. of Mathematics, Ill.

COLLINEATION GROUPS OF NON-DESARGUESIAN PLANES. II. SOME SEMI-NUCLEAR DIVISION ALGEBRAS, by D. R. Hughes. Mar. 1959, 12p. (AFOSR-TN-59-281) (AF 18(600)1383) AD 212914; PB 142366
Unclassified

Also published in Amer. Jour. Math., v. 82: 113-119, Jan. 1960.

Two classes of non-associative division algebras and the projective planes they coordinatize are considered with the aim of determining the collineation groups of the planes. These are the fourth and fifth classes of finite non-Desarguesian planes so analyzed, and, like the twisted fields, the groups are solvable. This is in sharp contrast to the other two situations, the finite Hall Veblen-Wedderburn planes and the (non-Veblen-Wedderburn) Hughes planes, both of which have non-solvable collineation groups. Since both the Hall and Hughes planes appear more removed from the Desarguesian planes than any division ring plane, it is perhaps peculiar that all the known finite non-associative division ring planes have solvable groups. (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

SIMPLICIAL TOPOLOGY I, by S. MacLane and J. Yao.
Mar. 1959, 42p. incl. diagrs. (AFOSR-TN-59-361)
(AF 18(600)1383) AD 213671; PB 140896
Unclassified

Studies on simplicial complexes and their applications in abstract homotopy theory and adjoint functions are reported. Much of the material is derived from the lectures of S. MacLane during the winter of 1959. The conceptual proofs of several theorems is given showing the possible complexes that satisfy the properties of a fiber space. The application of these groupings to homotopy theory is then given.

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GROUP EXTENSIONS BY PRIMARY ABELIAN GROUPS, by S. MacLane. May 1959, 26p. (AFOSR-TN-59-457) (AF 18(600)1383) AD 315262; PB 144935
Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 1-16, Apr. 1960.

The effective calculation of the functor $\text{Ext}(A, G)$ is considered which is defined as the group of all Abelian group extensions of the Abelian group G by the Abelian group A . For finitely generated A , the functor is known: (1) it is additive in A , (2) $\text{Ext}(Z, G) = 0$ when $A = Z$ is the infinite cyclic group and (3) for A the finite cyclic group Z/mZ of order m , $\text{Ext}(Z/mZ, G) = G/mG$. The case when A is a torsion group is considered. The assumption is made that A is a p -primary group T , i.e., a group in which every element has order a power of the prime p . (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

SEMINUCLEAR EXTENSIONS OF GALOIS FIELDS, by D. R. Hughes and E. Kleinfeld. Apr. 1959, 7p. (AFOSR-TN-59-497) (In cooperation with Ohio State U., Columbus) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1383 and Office of Ordnance Research) AD 215922; PB 142358
Unclassified

Also published in Amer. Jour. Math., v. 82: 389-392, July 1960.

Consideration is given to the problem of obtaining all division rings R (not associative) that are quadratic extensions of a Galois field F , where F is to be contained in the right and middle nuclei of R . This problem was inspired by the discovery of such a division ring with 16 elements. A new class of finite division rings and a corresponding class of projective planes are obtained. It is found that every Galois field not a prime field is capable of being extended in this way. If R is further restricted, so that F is to be contained in the nucleus of R , then exactly those Galois fields which are themselves quadratic extensions permit such an extension. (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

THE TEN TYPES OF H-SPACES, by I. M. James. Aug. 1959, 10p. incl. refs. (AFOSR-TN-59-857) (AF 18(600)1383) AD 228377; PB 144495
Unclassified

The 10 types of H-spaces are classified as follows: (1) equivalent to an associative, commutative multiplication; (2) equivalent-associative and equivalent-commutative but not of type 1; (3) homotopy-associative and equivalent-commutative but not equivalent-associative; (4) homotopy-commutative and equivalent-associative but not equivalent-commutative; (5) homotopy-associative and homotopy-commutative but neither equivalent-associative nor equivalent-commutative; (6) homotopy-associative but neither equivalent-associative nor homotopy-commutative; (7) homotopy-commutative but neither equivalent-commutative nor homotopy-associative; (8) equivalent-associative but not homotopy-commutative; (9) equivalent-commutative but not homotopy-associative; and (10) neither homotopy-associative nor homotopy-commutative.

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Chicago U. Dept. of Mathematics, Ill.

REVIEW OF SOME RESULTS IN COLLINATION GROUPS, by D. R. Hughes. Oct. 1959, 17p. incl. refs. (AFOSR-TN-59-1124) (AF 18(600)1383) AD 230410; PB 145486
Unclassified

Presented at Finite Groups Symposium, New York, N. Y., Apr. 23-24, 1959.

Also published in Proc. Symposium in Pure Math., v. 1: 42-55, 1959.

Collineation groups of finite projective planes are reviewed. The classical aspects of Desarguesian geometry, and the infinite planes are disregarded. Basic fundamentals, including non-existence theorems and configuration theorems are discussed. Known finite non-Desarguesian planes are listed and their collineation groups, so far as they have been determined, are given.

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[Chicago U. Dept. of Mathematics, Ill.]

SECONDARY COHOMOLOGY OPERATIONS: TWO FORMULAS, by F. P. Peterson and N. Stein. [1959] [25]p. incl. diagrs. refs. (Also bound with its AFOSR-TN-57-759; AD 135759) (In cooperation with Princeton U., N. J.) (AF 18(600)1383 and AF 18(600)1494)
Unclassified

Published in Amer. Jour. Math., v. 81: 281-305, Apr. 1959.

Two formulas are given relating secondary cohomology operations to primary and functional primary cohomology operations. A discussion is also presented on the higher order cohomology operations, paying particular attention to the difficulties which arise in the non-stable cases. The 2 formulas which are proven are as follows. Let Φ be a secondary operation coming from the relation $\Phi^2 = 0$, where $\Phi \in H^{n'+1}(\pi; \pi')$ and $\Phi' \in H^{q+1}(\pi', n' + 1; G)$. (1) Let $f: L \rightarrow K$ and let $u \in H^n(K; \pi)$ be such that $f^*(u) = 0$ and $\Phi(u) = 0$. Then $f^*\Phi(u) = {}^1\Phi'(\Phi_f(u)) \in H^q(L; G)/{}^1\Phi'(H^{n'}(K; \pi'))$, where ${}^1\Phi'$ denotes the suspension of Φ' . (2) Let $f: L \rightarrow K$ and let $u \in H^n(K; \pi)$ be such that $f^*\Phi(u) = 0$. Then $\Phi(f^*(u)) = \Phi'_f(\Phi(u)) \in H^q(L; G)/{}^1\Phi'(H^{n'}(L; \pi')) + f^*(H^q(K; G))$. The analogs of these formulas for some non-stable operations on more than one variable are also proven. In addition, applications of these 2 formulas are also shown. Finally, it is shown how the knowledge of secondary cohomology operations in the base of a fibre space gives information on primary cohomology operations in the total space.

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Chicago U. [Dept. of Mathematics] Ill.

ON THE LOCAL THEORY OF CONTINUOUS INFINITE PSEUDO GROUPS I, by M. Kuranishi. [1959] [36]p. (In cooperation with Inst. of Advanced Study, Princeton, N. J.) (AF 18(600)1383)
Unclassified

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Published in Nagoya Math Jour., v. 15: 225-260, Aug. 1959.

The theory of continuous infinite pseudo-groups of E. Cartan is developed by introducing parameter local groups. Chapter I is devoted to formal analytic mappings which generalize formal power series. In chapter II, using formal analytic mapping, the formal Lie (F)-groups and formal Lie (F)-algebras are defined. Lie's fundamental theorems are proved by establishing a 1-to-1 correspondence between the formal Lie (F)-groups and the formal Lie (F)-algebras.

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Chicago U. [Dept. of Mathematics] Ill.

FREE MONADIC ALGEBRAS, by P. R. Halmos. [1959] [9]p. (AFCSR-TN-59-858) (AF 49(638)30) AD 220959
Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 219-227, Apr. 1959.

A free monadic extension of a Boolean algebra B is a monadic algebra A with the properties that (1) B is a Boolean subalgebra of A, (2) A is (monadically) generated by B, (3) every Boolean homomorphism of B into a monadic algebra C can be extended to a monadic homomorphism of A into C. The following steps are shown to lead to a free monadic extension A of an isomorphic image of B: Let W be the space of all functions on B into a two-element Boolean algebra 2. Let X be the subspace of $W \times W$ consisting of all (y, v) such that y is a homomorphism, v is a hemimorphism and $y \leq v$. Let A be the dual algebra of X, i.e., the set of all continuous functions on X into 2, and for p in A define $\sup p$ by letting $(\sup p)(y, v)$ be the supremum of $p(u, v)$ ranging over all u with $(u, v) \in X$. The mapping h of B into A is defined by letting $h(p)(y, v) = p(y)$ for all p in B and $(y, v) \in X$. (Math. Rev. abstract)

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Chicago U. [Dept. of Mathematics] Ill.

THE REPRESENTATION OF MONADIC BOOLEAN ALGEBRAS, by P. R. Halmos. [1959] [8]p. incl. diagrs. (AFOSR-TN-59-1105) (In cooperation with Inst. for Advanced Study, Princeton, N. J.) [AF 49(638)30] AD 230221
Unclassified

Also published in Duke Math. Jour., v. 26: 447-454, Sept. 1959.

Presentation is made of a new proof of the fundamental representation theorem for monadic algebras, much simpler than the original one. Attention is also called to some hitherto unnoticed relations among 4 results: the monadic representation theorem, Sikorski's extension theorem for Boolean homomorphisms, Gleason's characterization of "projective" compact spaces, and

Michael's theorem on cross sections of mappings with a zero-dimensional range. The representation theorem reads: If K is the set of all C-constants of a C-rich monadic algebra A, then A is isomorphic to a C-valued functional monadic algebra with domain K.

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Chicago U. [Dept. of Mathematics] Ill.

SUBJECTIVE PROBABILITY AND STATISTICAL PRACTICE, by L. J. Savage. Oct. 28, 1959 [45]p. incl. diagr. (AFOSR-TN-59-1161) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-391 and Office of Naval Research under Nonr 212109) AD 230444; PB 145491
Unclassified

The concept of subjective, or personal, probability has much to contribute to statistical practice. It leads to criticism and amplification of conventional methods and the development of new ones. This is illustrated in problems of estimation, where precise measurement can be shown to justify sharp and rather well-defined final probability distributions of parameters. (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

FUNCTION SPACES AND DUALITY, by E. H. Spanier. Mar. 1959, 57p. incl. refs. (Technical note no. 1) (AFOSR-TN-59-359) (AF 49(638)393) AD 213669; PB 142148
Unclassified

Also published in Ann. Math., v. 70: 338-378, Sept. 1959.

A more general and natural approach is described for the duality in S-theory. The duality is based on imbedding X and its dual X' in a sphere S^n in such a way that each is an S-deformation retract of the complement of the other. If Y and Y' are similarly defined, there is a duality isomorphism $D_n: \{X, Y\} \approx \{Y', X'\}$ of the S-groups having many of the properties of duality. The construction of this isomorphism involves factoring a map into a composite of inclusion maps and retractions by deformation, defining the dual of the map to be the composite of the duals of the factors, and then proving that the end results do not depend on the factorization and other choices involved in the construction. This method of defining duality map $f: S^k X \rightarrow S^k Y$ represents an element of $\{X, Y\}$ corresponding (under D_n) to the element of $\{Y', X'\}$ represented by a map $f: S^{k'} Y' \rightarrow S^{k'} X'$. A more explicit relation is given between maps representing corresponding elements of the S-groups. The concepts of spectrum and functional dual are developed. Using these concepts, a proof is presented of a theorem on the existence of an isomorphism characterized by homotopy commutativity. (ASTIA abstract)

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Chicago U. Dept. of Mathematics, Ill.

TWO REMARKS ON FIBER HOMOTOPY TYPE, by J. Milnor and E. [H.] Spanier. May 1959, 10p. incl. refs. (Technical note no. 2) (AFOSR-TN-59-545) (AF 49-(638)393) AD 216621 Unclassified

Also published in Pacific Jour. Math., v. 10: 535-590, 1960.

The normal sphere bundle of a manifold M^n imbedded in euclidean space is considered. It is shown that if the dimension of the euclidean space is sufficiently high, then the normal sphere bundle has the fiber homotopy type of a product bundle if, and only if, there exists an S-map from S^n to M^n of degree 1. The proof is based on the fact that the Thom space of the normal bundle is dual in the sense of Spanier-Whitehead to the disjoint union of M^n and a point. The tangent sphere bundle of a homotopy n-sphere is studied also. This has the fiber homotopy type of a product bundle if, and only if, n equals 1, 3 or 7. (Contractor's abstract)

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Chicago U. Dept. of Mathematics, Ill.

RESEARCH ON DUALITY AND HOMOTOPY THEORY, by E. H. Spanier. Technical rept. July 1, 1958-June 30, 1959. July 1959 [1]p. (AFOSR-TR-59-83) (AF 49-(638)393) Unclassified

The progress made to date under this contract is reported. In the 1st report (item no. 323, Vol. III) a new approach to the duality in the suspension category which is based on properties of function spaces is discussed. The 2nd (item no. 324, Vol. III) relates the fiber homotopy type of the normal bundle of a manifold imbedded in euclidean space to properties of the manifold itself. It is reported also that work is now being prepared on the suspension categories with coefficients and a new approach to higher order cohomology operations and will be presented later.

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Chicago U. Dept. of Mathematics, Ill.

NOTE ON THE PRESERVATION OF CLASSES OF FUNCTIONS, by A. Zygmund. Apr. 1959, 13p. (Technical note no. 2) (AFOSR-TN-59-370) (AF 49(638)451) AD 213860; PB 140999 Unclassified

Also published in Jour. Math. and Mech., v. 8: 889-895, Nov. 1959.

The problem is solved for the necessary and sufficient conditions of a 2-way infinite sequence of numbers to be of type (P,Q), where P and Q are any 2 classes of peri-

odic functions, or, alternately the classes of Fourier series of such functions. A 2-way infinite sequence of numbers is of type (P,Q) if whenever $\sum_n e^{inx}$ is in P, $\sum_n \lambda_n e^{inx}$ is in Q. The class λ_α ($0 < \alpha < 1$) of periodic functions f is considered such that $f(x+h) - f(x) = O(h^\alpha)$ for $h \rightarrow 0$. (ASTIA abstract)

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Chicago U. Dept. of Mathematics, Ill.

ON THE EXISTENCE OF CONJUGATE FUNCTIONS OF HIGHER ORDER, by M. Weiss and A. Zygmund. Apr. 1959, 23p. (Technical note no. 1) (AFOSR-TN-59-371) (AF 49(638)451) AD 213859; PB 140998 Unclassified

Also published in Fundamenta Math., v. 48: 175-187, 1959.

Properties of certain extensions are investigated for the notion of conjugate function. The following theorem is proved: Let $f(x)$ be periodic and integrable and suppose that $f_{(r-1)}(x)$ exists at each point of a set E of positive measure. Then a necessary and sufficient condition for the r-th conjugate $\tilde{f}_r(x)$ to exist almost everywhere in E is that the indefinite integral of f has a generalized derivative of order $r+1$ almost everywhere in E. (ASTIA abstract)

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SINGULAR INTEGRALS, by V. E. Morley. [1959] 21p. (Technical note no. 3) (AFOSR-TN-59-373) (AF 49-(638)451) AD 213857; PB 140997 Unclassified

The existence and properties are considered for certain singular integrals in n-dimensional Euclidean space E^n . The integrals are of the type $\int_{E^n} K(P;Q)$ $f(Q)dQ = \int K(P;Q) f(P-Q)dQ$, where $K(P;Q) = \Omega(P;Q')/|Q|^n$. The presentation of results are discussed for the marginal cases when f is in L or $L \log L$. If f is restricted to be a member of $L_p(E^n)$, the integral is viewed as defining a linear transformation on $L_p(E^n)$. Only L_p classes for $1 < p < 2$ are treated. The convergence of f_ϵ as $\epsilon \rightarrow 0$, is studied. Under suitable restrictions on $\Omega(P;Q)$, proofs are presented that the \tilde{f}_ϵ converge in L_p norm with $\|\tilde{f}_\epsilon\|_p \leq A_p \|f\|_p$ for the f in L_p , $1 < p < 2$, and that f_ϵ converges almost everywhere for f in L_1 . (ASTIA abstract)

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Chicago U. Dept. of Mathematics, Ill.

A NOTE ON SMOOTH FUNCTIONS, by M. Weiss and A. Zygmund. [1959 [7]p. (Technical note no. 4) (AFOSR-TN-59-400) (AF 49(638)451) AD 21452C
Unclassified

Also published in Koninkl. Nederl. Akad. Wetensch. Proc., Indag. Math., v. 62A: 52-58, 1959.

Proof is presented for the following theorems: (1) If $F(x)$ is periodic and for some $\beta > 1/2$ satisfies $\Delta^2 F(x, h) = F(x+h) + F(x-h) - 2F(x) = O\left(\frac{h}{\log h}^\beta\right)$ uniformly in x , then F is the indefinite integral of an f belonging to every L^p . This theorem permits simplification of Salem's theorem (Koninkl. Nederl. Akad. Wetensch. Proc., v. 57A: 550-557, 1954). (2) Suppose that a periodic and continuous F satisfies the condition $\Delta^2 F(x, h) = o\left(\frac{h}{\log h}\right)$ and let S_n and σ_n be respectively the partial sums and $(C, 1)$ means of $S[F]$ (i.e. $S[F]$ differentiated termwise). Then $S_n - \sigma_n \rightarrow 0$ uniformly in x . It is pointed out that theorem 1 does not hold true for $\beta = 1/2$. Theorem 2 is generalized in the metric L^p . (Math. Rev. abstract)

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Chicago U. Dept. of Mathematics, Ill.

NON-UNIQUENESS IN CAUCHY'S PROBLEM, by A. Plis. Aug. 1959, 9p. (Technical note no. 5) (AFOSR-TN-59-1034) (AF 49(638)451) AD 228409; PB 145070
Unclassified

Also published in Jour. Math. and Mech., v. 9: 557-562, July 1960.

Proof is presented of the following theorem: There exists a linear system of partial differential equations of elliptic type for which the Cauchy problem possesses 2 distinct solutions of class C^∞ . The leading coefficients are constant and the remaining ones are of class C^m ($0 < m < \infty$). The (imaginary) characteristics are $(m+3)$ -fold. The system consists of $2(m+3)$ complex equations in 2 independent (real) variables; it corresponds to $4(m+3)$ real equations defined on the whole plane.

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Chicago U. [Dept. of Psychology] Ill.

FREQUENCY DISCRIMINATION AFTER SECTION OF BRACHIUM OF THE INFERIOR COLICULUS (Abstract), by J. M. Goldberg, B. A. Dalen, and W. D. Neff. [1959] [1]p. (Sponsored jointly by Air Force Office of

Scientific Research under [AF 49(638)99] and Office of Naval Research) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1575, Nov. 1959.

After complete bilateral section of the brachium of the inferior colliculus, cats cannot relearn in auditory frequency discrimination, a task which can be easily relearned after ablation of all known auditory neocortical areas and the subsequent degeneration of the thalamic auditory nuclei (the medial geniculate body and the posterior nucleus). The problem can be relearned when a small part of the brachium remains intact; the rate of relearning depends upon the anatomical locus of the remaining fibers. These results suggest that the brachium may contain fibers that do not end in the medial geniculate body and that these fibers, which probably come from the inferior colliculus and/or the nucleus of the lateral lemniscus, play an important role in the neural mechanisms underlying frequency discrimination.

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

[NEW DETERMINATION OF THE DECAY RATE OF NATURAL TRITIUM AND THE QUESTION OF THE ORIGIN OF NATURAL TRITIUM] Neubestimmung der natürlichen Tritium-zerfallsrate und die Frage der Herkunft des natürlichen Tritium, by F. Begemann. [1959] [28]p. incl. diagrs. tables, refs. (AFOSR-TN-59-66) (AF 18(600)564) AD 209610
Unclassified

Also published in Zeitschr. Naturforsch., v. 14a: 334-342, Apr. 1959.

The decay rate of "natural" tritium has been redetermined from measurements of the tritium content of old snow samples from Greenland. The finding by Craig and Begemann and Libby has been confirmed that the tritium decay rate is about 10 times higher than was anticipated previously. Two mechanisms to explain the discrepancy are discussed, (a) production by the low energy component of the cosmic radiation and (b) the accretion of solar tritium by the earth, as suggested by Feld and Arnold. It is shown that in case all the tritium is produced by cosmic radiation, the tropospheric production rate may be expected to vary in antiphase with the sunspot cycle, whereas in case of accretion of solar tritium by the earth, the variation should be in phase with the sunspot cycle. In both cases a phase shift between the stratospheric production rate and the amount of tropospheric tritium is to be expected because of the residence time of tritium in the stratosphere. A measurement of the phase shift should enable the determination of this residence time. The data obtained on the Greenland samples appear to show such a variation of the production rate. The results can be explained best by assuming that all the tritium is

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produced by cosmic radiation. This result, however, is only preliminary. More systematic measurements are required to decide between the 2 possibilities. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

[$^3\text{He} - ^3\text{H}$ RADIATION AGE OF A STONE METEORITE]
 $^3\text{He} - ^3\text{H}$ - Strahlungsalter eines Steinmeteoriten, by F. Begemann, P. Eberhardt, and D. C. Hess. [1959] [11]p. incl. diagr. tables, refs. (AFOSR-TN-59-434) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)564 and Atomic Energy Commission under AT(11-1)101) AD 214796

Unclassified

Also published in Zeitschr. Naturforsch., v. 14A: 500-503, May-June 1959.

The tritium and ^3He contents of 3 samples of the ABEE stone meteorite have been measured. Within the experimental limits of error both are found to be the same at the surface and near the center of the meteorite. At the time of the fall of the meteorite (1952) the tritium activity was (0.26 ± 0.04) disintegrations/min g. The ^3He content was measured to be $(0.13 \pm 0.01) \times 10^{-6}$ cc STP/g. The amount of ^3He accumulated and the tritium decay rate yield a maximum radiation age of 30 million yr. If it is assumed that equal amounts of ^3He and ^3H are produced by the interaction of cosmic rays with the meteoritic matter, the radiation age is 15 million yr.

The $^4\text{He}/\text{U}$ -age of the meteorite is greater than 3800 million yr. The possible significance of this discrepancy is discussed. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

THE PRIMARY COSMIC RAY PROTON AND ALPHA PARTICLE INTENSITIES AND THEIR VARIATION WITH TIME, by P. Meyer. Apr. 1959 [32]p. incl. diagrs. tables, refs. (Rept. no. EFLNS 59-10) (AFOSR-TN-59-455) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)666 and U. S. Committee for the I.G.Y.) AD 233359

Unclassified

Also published in Phys. Rev., v. 115: 1734-1741, Sept. 15, 1959.

A series of high altitude balloon flights was conducted in 1957 and 1958 to study the flux of primary cosmic ray protons and α -particles during variations in the total cosmic ray intensity. The following results were obtained for α -particles with energies exceeding 530 mev/nucleon under 13.5 g/cm^2 of air: (1) during a large Forbush-type decrease the α -particle and proton

intensities were closely correlated; (2) at certain times variations in the α -particle intensity were observed within a few hours which were not accompanied by corresponding changes in the proton flux; and (3) while there existed an intensity decrease in the proton flux between 1957 and 1958 which is also observed in the neutron monitor station data, no such variation occurred in the α -particle flux. A division of the α -particles into 2 energy groups ($450 \text{ mev/nucleon} < E_1 < 960 \text{ mev/nucleon}$ and $E_2 > 960 \text{ mev/nucleon}$) shows (1) that the Forbush decrease is of the same magnitude in both energy groups; (2) that the hourly flux increase observed in some flights is about the same in both energy groups; and (3) that from 1957 to 1958 the flux in the low energy group increased, while it decreased in the high energy interval, contrary to the well known behavior of the proton flux. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

PLASMA DYNAMICAL DETERMINATION OF SHOCK THICKNESS IN AN IONIZED GAS, by E. N. Parker. [1959] [7]p. incl. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)666] and AFCRC Geophysics Research Directorate) Unclassified

Published in Astrophys. Jour., v. 129: 217-223, Jan. 1959.

It is shown that the principal interaction in a shock front in a tenuous ionized gas is a plasma interaction in which the ions transfer their translational energy to the plasma oscillations. The effect is, of course, of interest in auroral theories and in solar radio noise. It turns out to be the dominant effect in determining shock thicknesses nearly everywhere that the gas density is less than the solar photospheric value of 10^{16} atoms/cm³. It is estimated that shock thicknesses in interstellar H II regions and in interplanetary space will be 1 km or less, even though the mean free paths may be 10^8 km or more than the ion Larmor radius ~ 100 km. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

FINAL STATE INTERACTION IN ^5He DECAY, by R. G. Ammar, R. Levi Setti and others. May 1959 [19]p. incl. diagrs. tables. (Rept. no. 318) (AFOSR-TN-59-1021) (In cooperation with Northwestern U., Evanston, Ill.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)209, Atomic Energy Commission and National Science Foundation) AD 234947

Unclassified

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Also published in Nuovo Cimento, Series X, v. 13: 1156-1164, Sept. 1959.

The distribution of certain kinematic quantities defined in the decay ${}^A\text{He}^5 \rightarrow \pi^- + p + \text{He}^4$ are interpreted as being due to the presence of a strong final state interaction. In particular the data are discussed with reference to two simple theories, one of which takes into account the specific $p - \text{He}^4$ nuclear interaction. The experimental evidence, although not conclusive, is consistent with the expectation that the $p - \text{He}^4$ $p_{3/2}$ resonance plays an important role in determining the final state configurations. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

A POSSIBLE EXPERIMENTAL METHOD FOR THE PRODUCTION AND DETECTION OF HEAVY HYPERFRAGMENTS, by R. Levi Setti and W. E. Slater. [1959] [3]p. incl. illus. diagr. (AFOSR-TN-59-1022) (AF 49(638)209) AD 234948 Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 895-897, 1959.

A process of production is devised in which large energies can be imparted to very heavy nuclear fragments. In the experiment a uranium-loaded stack of 80 600 μm Ilford G-5 2 in. x 4 in. was exposed to an enriched beam of K^- moderated so as to stop in the stack. The uranium concentration was found to be $2.6 \cdot 10^{20}$ nuclei/cm³ or 0.6% of all nuclei of the dry emulsion excluding hydrogen. It is shown that the K^- induced fission is slightly asymmetric, yielding a probable proton and 2 heavy particles of unequal mass. Because the evidence suggests that the initiating particle must have been much heavier than a muon, it is concluded that it was a K^- and that track p was probably caused by a proton.

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

A POSSIBLE METHOD OF SPECIFIC CHARGE IDENTIFICATION FROM PROFILE MEASUREMENTS IN NUCLEAR EMULSIONS, by R. G. Ammar. [1959] [12]p. incl. diagrs. table. (AFOSR-TN-59-1023) (AF 49(638)209) AD 234949 Unclassified

Also published in Nuovo Cimento, Series X, Suppl., v. 15: 181-192, 1960.

A discussion is given of a method of specific charge identification in nuclear emulsions (e.g. 1200 μm thick K-5 pellicles processed unmounted) requiring $\sim 50 \mu\text{m}$ projected range. Using a constant cell length t , the

width of the track T_n was measured at each residual range nt , yielding a distribution $\{T_n\}$. Typically $\{T_n\}$ consisted of 100 measurements made at a basic cell length $t \approx 0.57 \mu\text{m}$. Each track was subjected to about three such measurements in order to estimate the measurement errors. The mean T and standard spread σ of this distribution, which are conventional charge sensitive parameters, often require normalizations for best results. A search amongst the dimensionless parameters associated with the distribution $\{T_n\}$ indicates that the third moment of the distribution, $\alpha_3 = \sum (T_n - T)^3 / n$, is a charge sensitive parameter. A truncated distribution $\{T'_n\}$ with mean \bar{T}' , spread σ' and skewness $\alpha(\rho')$ is derived from $\{T_n\}$ by replacing all $T_n > \bar{T}' + \rho\sigma'$ by $\bar{T}' + \rho\sigma'$. $\alpha(\rho')$ with $\rho = 3.75$ is found to be the most sensitive parameter of those tried. It is presumed that its ability to discriminate is based on the presence of 'sub- δ -rays' and the tendency to form gaps.

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

HYPERFRAGMENTS PRODUCED BY K^- CAPTURE IN NUCLEAR EMULSION: π^0 DECAY MODES, by R. G. Ammar. [1959] [23]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1024) (AF 49(638)209) AD 234950 Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 1226-1248, Dec. 1959.

A systematic study was made of the π^0 -decays of light hypernuclei ($A \leq 5$) produced by K^- capture in nuclear emulsion. Approximately $3 \cdot 10^4$ K^- stars were examined, yielding a total of 94 1-prong events satisfying the following conditions: $R_c \geq 5 \mu\text{m}$, $8 \mu\text{m} \leq R_0 \leq 50 \mu\text{m}$, $0 \leq \theta \leq 60^\circ$, where R_c is the range of the primary (connecting track), R_0 that of the secondary (recoil) and θ the angle between their directions at their point of intersection. Of the 69 events which could be charge (Z) identified, 55 had $Z = 1$ and 14 $Z = 2$. In the $Z = 1$ category the true π^0 -events could not be separated from 1-prong π^- -events because of the overwhelming ($\approx 90\%$) contribution of the latter. It is concluded that probably all the 14 $Z = 2$ events represent true ${}^A\text{He}$ decays ($\sim 10 {}^A\text{He}^4$ and $\sim 4 {}^A\text{He}^5$). In addition, three 2-prong events were consistent with the interpretation as ${}^A\text{He}^4$ decays. One can define for the π^0 decays of ${}^A\text{He}^4$ the ratio: $R'({}^A\text{He}^4) = (\text{two-body decays})/(\text{all decays} - \text{'unobservable' ones})$; the 'unobservable' ones being π^0 -neutron-recoil

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decays with recoil momenta < 110 mev/c and other modes with ≥ 1 neutron. A value $R'(\text{He}^4) = 0.82^{+0.15}_{-0.16}$ is found. (Contractor's abstract)

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Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

MESIC DECAYS OF HYPERNUCLEI FROM K^- CAPTURE. I. BINDING ENERGIES, by R. [G.] Ammar, R. Levi Setti and others. [1959] [20]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1025) (In cooperation with Northwestern U., Evanston, Ill.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)209, Atomic Energy Commission, and National Science Foundation) AD 238741

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., May 1-3, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 175, May 1, 1958.

Also published in Nuovo Cimento, Series X, v. 15: 181-200, Jan. 1960.

The analysis of 134 uniquely identified mesic decays yields increased accuracy in the knowledge of the binding energies of the hypernucleides ${}^3_{\Lambda}\text{H}$, ${}^4_{\Lambda}\text{He}$, ${}^5_{\Lambda}\text{He}$, ${}^7_{\Lambda}\text{Li}$, ${}^8_{\Lambda}\text{Li}$, ${}^9_{\Lambda}\text{Li}$, and ${}^9_{\Lambda}\text{Be}$. In addition, individual examples of the new species ${}^7_{\Lambda}\text{He}$, ${}^{11}_{\Lambda}\text{B}$ and ${}^{12}_{\Lambda}\text{B}$ are described. The present data are combined with those collected in the EFINS survey. The isotopic spin multiplet structure of the light hypernuclei is discussed with reference to the information derived from the binding energies. (Contractor's abstract)

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Chicago U. [Enrico Fermi Inst. for Nuclear Studies] Ill.

PRECESSION OF THE POLARIZATION OF PARTICLES MOVING IN A HOMOGENEOUS ELECTROMAGNETIC FIELD, by V. Bargmann, L. Michel, and V. L. Telegdi. [1959] [2]p. incl. refs. [AF 49(638)209]

Unclassified

Published in Phys. Rev. Ltrs., v. 2: 435-436, May 15, 1959.

Covariant classical equations of motion of the spin are formulated for the axial 4-vector describing the polarization. In addition some special cases of practical interest are considered.

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Chicago U. Inst. for the Study of Metals, Ill.

THE EFFECT OF PRESSURE ON SELF-DIFFUSION IN LEAD, by N. H. Nachtrieb, H. A. Resing, and S. A. Rice. Feb. 1959 [13]p. incl. diagrs. table, refs. (AFOSR-TN-59-24) (AF 18(600)1489) AD 208754; PB 138703

Unclassified

Also published in Jour. Chem. Phys., v. 31: 135-138, July 1959.

Data are presented for the self-diffusion of lead as a function of temperature from 174° to 322° and for pressures from 1 to 8100 atm. The decrease in the self-diffusion coefficient with pressure follows a relationship of the form:

$$\frac{d \ln D}{d\xi} = -\frac{1}{RT_0} \left[Q_0 - \frac{\Delta V_{\text{act}}}{dT_m} \frac{dT_m}{dP} \right], \text{ where } \xi = \frac{T_m}{T}$$

T_0 and Q_0 are the normal melting point and the zero pressure activation energy, respectively, and ΔV_{act} is the activation volume. To 1st order the derivative is constant, deviations arising at high pressure because of the pressure-dependence of $\frac{dT_m}{dP}$. Several relationships are derived from thermodynamic considerations of the activated state, and are shown to be valid experimentally: (1) $\Delta H_{\text{act}} = bRT_m$ with $b = 20.7$, and (2) $\Delta H_{\text{act}} = \Delta H_m - \frac{\Delta V_{\text{act}}}{\Delta V_m}$, where ΔH_m and ΔV_m are the latent heat and volume change on fusion, respectively. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

A METHOD OF PREPARING THIN FILMS OF ALLGYS SUITABLE FOR OPTICAL STUDIES, by L. G. Schulz. Feb. 1959 [17]p. incl. diagrs. (AFOSR-TN-59-25) (AF 18(600)1489) AD 208755; PB 138702

Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 1191-1195, Dec. 1959.

An experimental procedure is described for producing thin films of binary alloys by evaporation and condensation in a vacuum. The components of the desired alloy are evaporated successively and the alloy is then produced by diffusion. A feature of the method is the use of a rotating modulator located between the vapor source and the substrate which controls the relative thickness of the deposit. During the first evaporation a uniform gradient of one metal is deposited. The

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substrate is then rotated 180° in its own plane and a gradient of another material is superposed. This results in a sample of approximately uniform thickness with pure metal components at the ends and with a composition gradient in between. The procedure is easily extended to permit the production in one evaporation of several samples having different thicknesses. An annealing treatment is usually helpful in promoting diffusion. Representative results on several alloys are described. (Contractor's abstract)

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Chicago U. Inst. for the Study of Metals, Ill.

ON THE DYNAMICAL THEORY OF DIFFUSION IN CRYSTALS. II. PRESSURE DEPENDENCE OF THE SELF DIFFUSION CONSTANT, by S. A. Rice and N. H. Nachtrieb. Mar. 1959, 22p. incl. refs. (AFOSR-TN-59-93) [AF 18(600)1489] AD 210183; PB 139556
Unclassified

Also published in Jour. Chem. Phys., v. 31: 139-145, July 1959.

A dynamical theory of diffusion developed previously is extended to the study of the pressure dependence of the self diffusion constant. Application of the theory is made to Na and Pb. For Pb, the computed heat of activation is 23,300 cal to be compared with the experimental value of 23,210 cal. (Contractor's abstract)

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Chicago U. [Inst. for the Study of Metals] Ill.

DIFFUSION OF Ga, As, Cd, AND Hg IN Cu (Abstract), by C. T. Tomizuka and D. L. Garrett. [1959] [1]p. [AF 18(600)1489] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 171, Mar. 30, 1959.

The diffusion of various types of impurities in single crystals of copper was studied with the standard technique of radioactive tracers and lathe sectioning. The activation energies and the frequency factors are determined over a temperature range of 700°-1040°C. The results indicate that the electronic screening does not necessarily account for the observed change in the activation energy. They also suggest that it is impossible to isolate the effect of excess electronic charge from that of the elastic strain introduced by the impurities.

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Chicago U. [Inst. for the Study of Metals] Ill.

EFFECT OF SIMULTANEOUS TORSIONAL STRAIN ON SELF-DIFFUSION IN SILVER (Abstract), by J. B. Darby, Jr., C. T. Tomizuka, and R. W. Balluffi. [1959] [1]p. [AF 18(600)1489] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 171-172, Mar. 30, 1959.

The effect of deformation on silver self-diffusion, previously investigated for extension and compression, was studied during torsion. Polycrystalline rods of high-purity silver with an initial grain size $\approx (\frac{1}{2} - 3 \text{ mm})$ were plated with Ag^{110} and were simultaneously twisted and diffused in the range 790-800°C. The penetration curves were obtained by sectioning. No enhancement of diffusion was observed within the estimated experimental error in the diffusivity ($\pm 20\%$). Strain rates between 1.6×10^{-5} and $14 \times 10^{-5} \text{ sec}^{-1}$ and strains ≤ 0.5 were employed. These results are consistent with the previous data which indicate that the effects of plastic deformation are small at these relatively high temperatures. The results disagree markedly with those of Lee and Maddin who report enhancements 2 orders of magnitude larger than the present results under comparable experimental conditions. The results will be compared with those of other workers in the field. Further work at lower temperatures is continuing.

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Chicago U. [Inst. of Radiobiology and Biophysics] Ill.

STUDIES OF THE SCANNING X-RAY SYSTEM AS A MEANS OF EXAMINING STRUCTURE, by R. J. Moon. [Final rept.] Sept. 1955, 98p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-179) (AF 18(600)565) AD 249432
Unclassified

The primary goal of this research was the development of a scanning x-ray system which would effectively and in a practical way produce an x-ray image with much more information at a greatly reduced dosage than with conventional methods. Much of the projected goal was achieved, although continuous operation of the scanning x-ray tube at 100 ma and 125 kv was not accomplished, as intended. The currents and voltages at which the tube was operated indicated, however, the feasibility of achieving this level of operation. A suitable fluorescent crystal detector was developed. The electron optics of the scanning x-ray tube proved to be excellent. A pulse sorter was developed which is capable of handling 100,000,000 pps. A prototype memory tube was also constructed and used successfully. Studies were conducted

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on physical and biological specimens. The research work was brought to a state that indicates the necessity for the continued development of the scanning x-ray system.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

EVALUATION OF MOLECULAR INTEGRALS BY DIGITAL COMPUTER, by C. C. J. Roothaan. [1958] [3]p. (Bound with its AFOSR-TN-60-9; AD 232111; PB 154277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471, National Science Foundation, and Office of Naval Research under Nonr-212101) Unclassified

Also published in Jour. Chem. Phys., v. 28: 982-983, May 1958.

One of the goals of this research has been the development of a complete set of digital computer programs for all the integrals occurring in quantum-mechanical calculations, based on Slater orbitals. This being a formidable task, a more restricted objective was chosen 1st, namely the 2-center integrals arising from 1s, 2s, and 2p orbitals. A fully automatic program, using the Remington Rand 1103 computer, was recently completed. Extensive tests have proven the integrals reliable to at least 7 significant figures. The total computing time for all the necessary integrals for a diatomic molecule of 1st row atoms is 37 or 100 min for the homopolar or heteropolar case, respectively, for each value of R. Comparison of this program with others indicates the need for extension of the existing programs in 2 directions: higher quantum numbers; and 3- and 4-center integrals.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

[CORRELATED ATOMIC ORBITALS] Orbitales atomiques corrélées, by C. C. J. Roothaan. [1958] [2]p. Incl. diag. table. (Bound with its AFOSR-TN-60-9; AD 232111; PB 154277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471, National Science Foundation and Office of Naval Research under Nonr-212101) Unclassified

Published in Colloque Internat'l. sur le Calcul des Fonctions d'Onde Moléculaire, Paris (France), Paris, Centre National de la Recherche Scientifique, 1958, p. 49-50.

It is pointed out that one criticism of the function of n electrons based on the Hartree-Fock orbitals is that the electrons situated in the same orbital and having opposite spins must approach each other very often. In the case of 2 electrons the curve of the function bends abruptly toward a finite value when $r_{12} \rightarrow 0$ has been demonstrated by Hartree-Ingman. The Hartree-Fock

cure for 2 electrons was smooth when $r_{12} \rightarrow 0$. The formula $\Phi = \phi(r_1) \phi(r_2) \neq \phi(r_{12})$ is given and calculations of ϕ and Φ are made. The results show that the experimental value and that calculated by the Hartree-Fock formula to be in close agreement.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

[REPRESENTATION OF HARTREE-FOCK ATOMIC FUNCTIONS BY ANALYTICAL DEVELOPMENTS] Représentation des fonctions atomiques de Hartree-Fock par des développements analytiques, by C. C. J. Roothaan. [1958] [2]p. (Bound with its AFOSR-TN-60-9; AD 232111; PB 154277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471, National Science Foundation, and Office of Naval Research under Nonr-212101) Unclassified

Published in Colloque Internat'l. sur le Calcul des Fonctions d'Onde Moléculaire, Paris (France), Paris, Centre National de la Recherche Scientifique, 1958, p. 61-62.

A shorter and easier procedure is presented for finding the Hartree-Fock orbitals. The method consists of choosing a set of base functions and determining the atomic orbitals as being the best linear combinations possible that can be obtained from the set. The success of this procedure depends entirely on the choice of a good set of base functions, in order that an expression with as few terms as possible be obtained to produce the Hartree-Fock orbitals. As a test of this method, the orbital of helium is determined from the formula

$\phi = \sqrt{\frac{3}{\pi}} [a_0 + a_1(\zeta r) + a_2(\zeta r)^2] e^{-\zeta r}$. The energy obtained from this function is $E = 2.36159$ which compare favorably with $E = -2.36167$ obtained by using the established longer expression.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

[QUANTUM MECHANICAL COMPUTATIONS OF MOLECULAR PROPERTIES], by R. S. Mulliken, J. R. Platt and others. Technical rept. 1957-1958, Part I, 251p. Incl. illus. diagrs. tables, refs. (AFOSR-TN-59-1073) (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)1019 and AF 19(604)-3478, Air Force Office of Scientific Research under AF 18(600)471, Office of Naval Research under Nonr-212101, Office of Ordnance Research under DA-11-022-ORD-1002, and Wright Air Development Center under AF 33(616)5608) Unclassified

This report covers the period Jan. 1, 1957 through May 31, 1959 for all contracts. It contains 28 technical papers which are largely devoted to the subject of

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molecular spectroscopy and related matters. It also includes a group of theoretical papers on hyperconjugation, and 3 papers on free-electron molecular orbital theory. A large number of the included papers are reproduced from published reprints.

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Chicago U. [Lab. of Molecular Structure and Spectra] Ill.

[COMPUTATIONS ON INTEGRALS IMPORTANT IN QUANTUM CHEMISTRY], by R. S. Mulliken. Final rept. [1959] 4p. (AFOSR-TR-59-139) (AF 18(600)471) AD 230388 Unclassified

The progress of the research on this project is reviewed, from its inception in Oct. 1952 through May 1959. The accomplishments of the study have included the construction of electronic digital computer programs for computing exchange integrals, the development of a single-package program consisting of a combination of several integrals programs, aimed at computing all integrals rapidly to produce a self-consistent-field (SCF) molecular wave function in the sense of Roothaan's SCF LCAO method, and the development of a program for computing the 3- and 4-center interelectronic repulsion integrals for the case of linear molecules, by a new method.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

SUMMARY OF THEORETICAL WORK ON ATOMS AND MOLECULES, by B. J. Ransil. [1959] [9]p. incl. tables. (Bound with its AFOSR-TN-60-9; AD 232111; PB 154277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471, National Science Foundation, Office of Naval Research under Nonr-212101, and Wright Air Development Center under AF 33(616)5608) Unclassified

The work of this project has encompassed 4 broad areas of study: (1) improvement of existing mathematical techniques and development of new ones for calculating molecular integrals, for performing atomic and molecular variational procedures, and for atomic and molecular SCF procedures; (2) improvement and extensive development of existing methods and exploration of new ones for obtaining accurate atomic and molecular wave functions; (3) survey of selected diatomic molecules of the 1st row of the periodic table in single-determinantal LCAO-MO-SCF approximation with a basic set of Slater-type orbitals limited to inner and valence shell only; and (4) individual projects which related to 1 or all of the above. The technical papers emanating from this research, and the specific developments and results are discussed.

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Chicago U. Lab. of Molecular Structure and Spectra, Ill.

SURVEY OF DIGITAL COMPUTER PROGRAMS FOR COMPUTATION OF ELECTRONIC PROPERTIES OF ATOMS AND MOLECULES, by B. J. Ransil. [1959] [6]p. incl. tables. (Bound with its AFOSR-TN-60-9; AD 232111; PB 154277) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)471 and National Science Foundation) Unclassified

Three extensive libraries of digital computer programs for computing the electronic properties of atoms and molecules are described: (1) the library of univac scientific 1103 programs at WADC; (2) the library of univac scientific 1103A programs, also at WADC; and (3) the library of IBM 704 programs at National Bureau of Standards and Argonne National Lab. For the 1103, a molecular consistent field (SCF) program was written for computing SCF MO's approximated as linear combinations of atomic orbitals (SCF LCAO-MO's). The SCF program was then correlated with the various integrals programs and a versatile input-output format, to produce a completely automatic molecular program capable of computing the total electronic energy, ionization potentials, and wave functions of any closed-shell diatomic molecule of the 1st row of the periodic table and its hydride in a single-determinant LCAO-MO approx. For the 1103A, a generalized integrals program for computing all 1- and 2-electron molecular integrals for 2-, 3-, and 4-center linear molecules is near completion. An integrals program capable of computing atomic integrals for s orbitals only, has been completed in conjunction with a generalized SCF scheme for atoms. Three SCF routines are in various stages of progress. It is planned that the programming, now being handled by the 1103 computer will eventually be transferred completely to the 1103A, which is a faster machine than the 1103 in many aspects. A generalized integrals and SCF program for atoms has been developed for the IBM 704 at Argonne National Lab. and an SCF procedure has been coded at NBS. It is expected that a more extensive computer library will become available for the IBM 704 during 1960.

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Cincinnati U. Applied Science Research Lab., Ohio.

STUDIES OF THE DIELECTRIC PROPERTIES OF INSULATING LIQUIDS, by M. Ish-Shalom. Final rept. Feb. 20, 1959, 103p. incl. diagrs. tables, refs. (AFOSR-TR-59-31) (AF 49(638)271) AD 244645 Unclassified

Anomalous dispersion in viscous liquids was investigated. Anomalous dispersion is the phenomenon in which the dielectric constant of a substance decreases with increasing frequency of the measuring electric field. The decrease is accompanied by an increase in the loss factor. The macroscopic and microscopic aspects of the theory of dielectrics are discussed with respect to static properties, time dependent field,

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derivation of a Debye-type equation, distribution of times of relaxation, the Mossotti field and molar refraction, the Debye equation for molar polarization, the Onsager equation, and the Kirkwood equation. For the dynamic properties, consideration is given to Brownian motion (Debye) and the rate process. The dielectric properties of nitrobenzene solutions in 2 types of viscous solvents were studied at various temperatures and concentrations. One solution was a mixture of terphenyls and triphenylmethane and the other a low-molecular-weight butylene polymer. The common features of both systems were a high degree of skewness of the Cole-Cole plot, relatively high free energies of activation (8 to 10 kcal/mol), and high entropies of activation of the process of dielectric relaxation. The values of the free energies of activation and the entropies of activation of the viscosity were roughly of similar magnitude. The 2 solvents differed in the actual values of entropies of activation. After extrapolation to the temperatures at which the peak of the dielectric absorption lies between 1 and 10 kc/s, the viscosities of the solvents are about 50,000 to 100,000 poises.

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Colorado U. Dept. of Mathematics, Boulder.

TWIN CONVERGENCE REGIONS FOR CONTINUED FRACTIONS $1 + K(a_n/1)$ ONE OF WHICH IS THE CIRCULAR REGION $|a_{2n-1}| \leq \rho^2$, by W. J. Thron. [1959] 61p. (AFOSR-TN-175) (AF 49(638)100) AD 211315 Unclassified

Also published in Math Zeitschr., v. 70: 310-344, Feb. 1959.

A study is made of the continued fraction, $1 + \frac{a_1}{1} + \frac{a_2}{1} + \dots$, whose elements a_n are complex numbers.

Determination of twin convergence regions, one of the regions being the circular disk $|z| \leq \rho^2$, is considered. Regions G_ρ are sought such that the 2 conditions, $|a_{2n-1}| \leq \rho^2$ and $a_{2n} \in G_\rho$ for all $n \geq 1$, guarantee convergence of the continued fraction.

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Colorado U. [Dept. of Mathematics] Boulder.

SEQUENCES GENERATED BY ITERATION, by W. J. Thron. [1959] [19]p. (AFOSR-TN-59-938) (AF 49(638)-100) AD 226018; PB 145442 Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 38-53, July 1960.

Let g satisfy $0 < g(x) < x$ in some interval $0 < x < c$. If x_1 satisfies $0 < x_1 < c$, the sequence x_1, x_2, x_3, \dots is

determined by $x_{n+1} = g(x_n)$ ($n = 1, 2, 3, \dots$). Then $x_n \rightarrow 0$ and the question as to the asymptotic behavior arises. The behavior as far as it is independent of the initial element is of primary interest. Apart from a discussion of known facts concerning the case where $g'(0)$ exists with $0 < g'(0)$, all attention is devoted to the case where $g'(0) = 1$.

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Colorado U. [Dept. of Mathematics] Boulder.

A TWO-PARAMETER FAMILY OF BEST TWIN CONVERGENCE REGIONS FOR CONTINUED FRACTIONS, by L. J. Lange and W. J. Thron. [1959] 34p. (AFOSR-TN-59-130!) (AF 49(638)100) AD 229596; PB 144777 Unclassified

Also published in Math. Zeitschr., v. 73: 295-311, 1960.

A study is presented of the continued fraction $1 + \frac{a_1}{1} + \frac{a_2}{1} + \dots$, whose elements a_n satisfy the conditions: (1) $a_{2n-1} = c_{2n-1}^2$ for $|c_{2n-1} \pm ia| \leq \rho$ and (2) $a_{2n} = c_{2n}^2$ for $|c_{2n} \pm i(1-a)| \geq \rho$, where a is a complex number, and a and ρ satisfy the inequality $|a| < \rho < |1+a|$. These conditions are shown to be sufficient for the convergence of the continued fraction. The case is considered for which the elements of the continued fraction satisfy these conditions for real values of a . An elementary proof is given for the convergence of the continued fraction which establishes uniformity of convergence and gives an estimate of the speed of convergence. This proof employs only the fundamental concepts of complex variable theory. This basic theorem is shown to also hold true for complex values of a . For this case, a non-elementary proof is constructed which depends on the theory of functions of normal families.

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Colorado U. Dept. of Physics, Boulder.

LECTURES IN THEORETICAL PHYSICS. VOLUMES I AND II. LECTURES DELIVERED AT THE SUMMER INSTITUTE FOR THEORETICAL PHYSICS, COLORADO U., BOULDER, 1958-1959, ed. by W. E. Britten, B. W. Downs, and L. G. Dunham. New York, Interscience, 1959-1960, 2v. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-136) (In cooperation with Boulder Labs., Colo.) (AF 49(638)349) Unclassified

The purpose of these conferences was to promote a free exchange of ideas and information among investigators of theoretical physics. Lectures dealing with high-energy collision theory, interactions of strange particles, multiple production of mesons, nuclear theory, pair production in the field of an atom, particles with zero-mass, and statistical-mechanical theory of irreversible processes are discussed in the 1st volume. The 2nd volume

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contains articles on abstract field theory, the classical electron, hypernuclei and the Λ -nucleon interaction, invariance properties in elementary particle physics, quantum mechanical amplifiers, quantum mechanics' many body problem, symmetry laws, and the theory of beta decay.

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Columbia U. [Columbia Radiation Lab.] New York.

MASER ACTION IN RUBY IN THE 21-CM REGION (Abstract), by F. R. Arams, S. Okwit, and A. A. Penzias. [15.9] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279])

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 21, Jan. 28, 1959.

A 3-level ruby maser employing a partially superconducting fixed frequency cavity was operated at Columbia U. It employed the $1/2 \leftrightarrow -1/2$ and $3/2 \leftrightarrow -1/2$ transitions (employing the low field notation) for amplifying and pumping frequencies respectively. It was operated at low magnetic fields oriented at 67° relative to the crystal axis. A tunable maser was developed concurrently at Airborne Instruments Lab. Operation was obtained without the use of a superconducting cavity using the $-3/2 \leftrightarrow 3/2$ and $3/2 \leftrightarrow 1/2$ transitions at high magnetic fields oriented at 90° to the crystal axis. Operating parameters of the 2 masers will be given and the types of operation will be compared.

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Columbia U. Columbia Radiation Lab., N. Y.

ANTIFERROMAGNETIC RESONANCE IN MnF_2 , by F. M. Johnson and A. H. Nethercot, Jr. [1959] [12]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279])

Unclassified

Published in Phys. Rev., v. 114: 705-716, May 1, 1959.

Measurements of the antiferromagnetic resonance frequency, $\nu(T)$, were made on single-crystal slabs of MnF_2 in the frequency range 96 to 247.2 kmc/sec and at temperatures, T , ranging from 4.2°K to 64°K ($T_N = 67.7^\circ K$). The results are in general agreement with the resonance relations derived for antiferromagnetic materials by Nagamiya, Keffer, and Kittel, and others. At low temperatures, values of $\nu(T)/\nu(0)$ and $\nu(0)$ are consistent with spin-wave method calculation of the sublattice magnetization and of the value and temperature

dependence of the anisotropy energy. This agreement indicates almost complete correlation of adjacent electron spins in the low-temperature range as predicted from spin-wave theory. From the antiferromagnetic resonance measurement of $\nu(0) = 261.4 \pm 1.5$ kmc/sec and Oguchi's calculation of $H_A, z|J|$ is 3.94×10^{-15} erg, in agreement with other determinations. Antiferromagnetic resonance line widths were measured from 4.2°K to 64°K. The observed asymmetric line shapes are satisfactorily accounted for as arising from a mixing of absorption and dispersion and from reflections. A simplified line-width theory is given which satisfactorily accounts for the observed line widths except at the lowest temperatures, where a residual width is found. Finally, antiferromagnetic resonance measurements on 2 crystals, which were grown under different conditions, indicate no difference in resonance frequency or line width. (Contractor's abstract)

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Columbia U. [Columbia Radiation Lab.] New York.

A MASER AMPLIFIER FOR RADIO ASTRONOMY AT X-BAND, by J. A. Giordmaine, L. E. Alsop and others. [1959] [8]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research and Signal Corps under [DA 36-039-sc-73279])

Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 1062-1069, June 1959.

The design and operating characteristics of a maser radiometer for use in radio astronomy at 3-cm wavelength are discussed. The operating system which is described has a bandwidth of 5.5 mc and an input noise temperature, including background radiation into the antenna, of about 85°K. An rms fluctuation level of about 0.04°K is attained using an averaging time of 5 sec. A discussion of the factors determining the sensitivity of such devices is presented. (Contractor's abstract)

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Columbia U. Columbia Radiation Lab., N. Y.

FREQUENCY DEPENDENCE OF THE SURFACE RESISTANCE OF SUPERCONDUCTING TIN IN THE MILLIMETER WAVELENGTH REGION, by R. Kaplan, A. H. Nethercot, Jr., and H. A. Boorse. [1959] [10]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, and Signal Corps under [DA 36-039-sc-73279])

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 5, Jan. 28, 1959.

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Also published in Phys. Rev., v. 116: 270-279, Oct. 15, 1959.

The ratio of the superconducting to normal surface resistance of polycrystalline tin has been measured at 7 frequencies between 17 kmc/sec and 77 kmc/sec and at temperatures from 1.5°K to 3.0°K. These data plus those of other investigators have been compared with the predictions of 2 theories: the first a calculation made by Serber (unpublished) based on the London 2-fluid model of superconductivity and the Reuter-Sondheimer theory of the anomalous skin effect, and the second a calculation based on the Bardeen-Cooper-Schrieffer theory as developed by Bardeen and Mattis. Agreement between experimental and theoretical results is only fair in the case of the two-fluid theory. The best values of the relevant parameters, Fermi velocity v and mean free path l , were found to be, respectively, $(1.25 \pm 0.3) \times 10^7$ cm/sec and $10^{-3} - 10^{-1}$ cm.

A value of v approximately 10^8 cm/sec would be expected of tin. The surface resistance ratio from the Bardeen-Cooper-Schrieffer theory has been calculated only for the extreme anomalous limit and the calculation therefore should not apply too accurately for tin. However, a curve of the right general shape is obtained and further calculations more appropriate to tin should improve the agreement between theory and experiment.

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Columbia U. Columbia Radiation Lab., New York.

BEAM MASER SPECTROSCOPY ON FORMALDEHYDE, by P. Thaddeus, J. Loubser and others. [1959] [2]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279])
Unclassified

Published in Jour. Chem. Phys., v. 31: 1677-1678, Dec. 1959.

Hyperfine structures of CH_2O and CHDO were made and analyzed. The former structure is due to 1-J and spin-spin magnetic interactions of the 2 protons. The isotopic substituted deuteron structure is compounded and is represented by $F_1 F$ where $I_D + J = F_1$, $I_H + F_1 = F$. The measured frequencies of the most intense $\Delta F_1 = \Delta F = 0$ transitions relative to the strongest line and the sum of the $F_1 = 3 - 3$ are given in table form. In the investigations it was assumed that the C-H distance = 1.094A, C-O distance = 1.20A and $\angle \text{HCH} = 118^\circ \pm 28'$.

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Columbia U. [Columbia Radiation Lab.] New York.

ATOMIC AND MOLECULAR BEAM SPECTROSCOPY, by P. Kusch and V. W. Hughes. [1959] 172p. incl.

diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-73279] and National Science Foundation)
Unclassified

Published in Handbuch der Phys., v. 37: 1-172, 1959.

The present article deals primarily with atomic and molecular beam spectroscopy. The 1st chapter on methodology includes discussions of the production, characteristics, detection, and deflection of beams of neutral particles, and of the theory and experimental technique associated with the transition process. The 2nd and 3rd chapters deal with atomic and molecular spectroscopy respectively. They include a summary of the theory of the energy levels studied, a discussion of the type of measurements that have been made and of the present limitations to the accuracy of the experiments, and a compilation of the more important data obtained. (Contractor's abstract)

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Columbia U. Columbia Radiation Lab., New York.

RESEARCH ON PHYSICS AND CHEMISTRY OF GASES AT HIGH TEMPERATURES, by P. Kusch. Final rept. Nov. 1, 1954-Oct. 30, 1959. Nov. 1959 [2]p. incl. refs. (AFOSR-TR-59-194) (AF 16(600)1334)
Unclassified

A brief explanation of the work done under this contract is presented. The reports include those previously reviewed (COU.20:003-009, Vol. II) and are concerned with the properties of the alkali halides in the gaseous phase. Evidence was obtained of the polymerization of most of the alkali halide species. Recently, it is reported, the work has taken a new direction to the properties of the metastable stages of certain atoms. This work has been successful and will be reported in subsequent publications.

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Columbia U. Dept. of Chemistry, N. Y.

THE HYPERFINE INTERACTION AND QUADRUPOLE COUPLING CONSTANT IN THE HYDROGEN MOLECULE ION, by M. J. Stephen and J. P. Auffray. Technical status rept. nos. 17-18, May 1-Oct. 31, 1958 [17]p. incl. tables, refs. (AFOSR-TN-59-546) (AF 16(600)-1152) AD 253123
Unclassified

Also published in Jour. Chem. Phys., v. 31: 1329-1332, Nov. 1959.

An accurate calculation has been made of the interaction between the electron spin magnetic moment and a nuclear moment for the ground state of the hydrogen molecule ion. An accurate value of the electric field gradient at the nucleus was also obtained. The values are compared with values from an approximate L.C.A.O.

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wavefunction. The possibility of observing the paramagnetic resonance spectrum of this molecule is discussed. (Contractor's abstract)

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Columbia U. [Dept. of Chemistry] New York.

PARAMAGNETIC RESONANCE ABSORPTION SPECTROSCOPY, by G. K. Fraenkel. Final rept. Apr. 1, 1955-Sept. 30, 1959, 9p. (Rept. no. 16; rept. no. CU-16-59 AF1390-Chem) (AF 18(600)1390) AD 230591; PB 145523
Unclassified

The research performed during this study of the paramagnetic resonance spectra of free radicals is reviewed. Investigations have been made into the mechanisms of proton hyperfine splitting in aromatic free radicals, and certain theories are being tested which suggest that the hyperfine splitting can be accounted for by a π -interaction and that the splitting may be related to the unpaired electron spin density on the carbon adjacent to the proton. Studies have been made of the electron resonance spectra of all the methyl- and chloro-substituted p-benzosemiquinones and the acid-stabilized semiquinones. Investigations of relaxation mechanisms, line broadening, and saturation indicated that the peak heights and line widths of the different hyperfine components in the spectra of the semiquinone ions were not the same and exhibited different degrees of saturation.

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Columbia U. Dept. of Chemistry, New York.

NUCLEAR AND PARAMAGNETIC RESONANCE, by G. K. Fraenkel and B. [G.] Segal. [1959] [22]p. incl. refs. [AF 18(600)1390] Unclassified

Published in Ann. Rev. Phys. Chem., v. 10: 435-456, 1959.

The existing literature on nuclear and paramagnetic resonance is reviewed. The discussion is restricted almost exclusively to electron spin resonance, and is concerned primarily with the ESR of free radicals. A comprehensive list of 276 references is appended.

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Columbia U. Dept. of Chemistry, New York.

THEORY OF SATURATION IN ELECTRON SPIN RESONANCE SPECTRA, by M. J. Stephen and G. K. Fraenkel. Sept. 23, 1959, 1v. incl. diagrs. tables, refs. (Technical note no. 2; rept. no. CU-2-59AF520-Chem) (AFOSR-TN-59-745) (AF 49(638)520) AD 230214; PB 144910
Unclassified

Also published in Jour. Chem. Phys., v. 32: 1435-1444, May 1960.

A theory of saturation in electron spin resonance spectra exhibiting hyperfine splitting is presented. This theory is used to study the saturation of free-radical spectra in solution; and several relaxation processes are investigated. It is shown that motional modulation of the intramolecular electron-nuclear anisotropic dipole-dipole interaction introduces a relation between the saturation parameters and the hyperfine components that varies symmetrically about the center of the spectrum and causes a smaller degree of relaxation for the components in the central portion of the spectrum than for those in the wings. This relaxation mechanism introduces a greater dependence on nuclear spin state for radicals with several magnetic nuclei than for radicals with only 1 such nucleus. It is also shown that a cross-term between this intramolecular dipolar interaction and motional modulation of the anisotropic g-tensor introduces a relaxation that varies linearly from 1 side of the spectrum to the other. Numerical values of the relaxation-induced transition probabilities are estimated for the benzene negative ion, and tables are given from which saturation factors can be computed for a variety of conditions for several different spin systems. The relation between the spin-lattice relaxation time, T_1 , and the parameters which determine saturation is discussed, and it is pointed out that these quantities are not equivalent in systems exhibiting cross-relaxation. (Contractor's abstract)

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Columbia U. Dept. of Chemistry, New York.

ANOMALOUS RELAXATION OF HYPERFINE COMPONENTS IN ELECTRON SPIN RESONANCE, by J. W. H. Schreurs, G. E. Blomgren, and G. K. Fraenkel. Jan. 1, 1960, 27p. incl. table, refs. (Technical note no. 3; rept. no. CU-3-60AF520-Chem) (AFOSR-TN-59-1326) (AF 49(638)520) AD 233724; PB 146749 Unclassified

Also published in Jour. Chem. Phys., v. 32: 1861-1869, June 1960.

It is shown that the different hyperfine components in the electron resonance spectra of free radicals exhibiting proton hyperfine splitting saturate at different rates, and different sets of relaxation times must be used to describe the behavior of each component. The variations in the relaxation times (T_1 and T_2) were found to be

approx symmetric about the center of the spectrum, and the central component is the narrowest and saturates more readily than the outer components. A qualitative discussion is given of the relaxation and line-broadening mechanisms which may be responsible for the variations in T_1 and T_2 . In solutions of the p-benzosemiquinone ion at room temperature, the values of T_1 and T_2 were found to be approx 10^{-6} sec. An analysis is given of the experimental parameters which affect saturation measurements, including the effect of a non-uniform r-f field in a rectangular cavity, and a study is made of the type of spectra to be expected when the individual hyperfine

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components have different values of T_1 and T_2 . An appendix is included on the work of Jen, et al. (Phys. Rev., v. 112: 1169, 1958), on deuterium atoms trapped at liquid helium temperature, which shows that the anomalous intensities obtained as a function of r-f power is not the same as the phenomenon observed for free radicals in solution, and cannot be adequately interpreted in terms of any currently proposed mechanisms. (Contractor's abstract)

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Columbia U. Dept. of Electrical Engineering, New York.

A TRANSPORT EQUATION FOR THE SPECTRAL DENSITY OF A MULTIPLY SCATTERED ELECTROMAGNETIC FIELD, by D. S. Bugnolo. Nov. 19, 1959 [23]p. incl. diagrs. refs. (Technical rept. no. T-3D; rept. no. CU-8-59AF350-EE) (AFOSR-TN-59-1175) (AF 49(638)350) AD 229905; PB 145315

Unclassified

Presented in part at IRE-URSI joint meeting, San Diego, Calif., Oct. 1959.

Also published in Jour. Appl. Phys., v. 31: 1176-1182, July 1960.

The use of a first Born approximation is open to question when the path length is greater than a mean free path in the scattering region. It is therefore of interest to develop a transport equation capable of predicting the spectral density for such cases. The general theory presented in this paper is applied to the case of multiple scattering by dielectric noise. It is independent of models for the dielectric fluctuations. A method of solution is developed for the case of forward scattering. The particular case of a monochromatic plane wave incident on a half space is discussed in detail. The results are applied to a numerical example in the troposphere. (Contractor's abstract)

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Columbia U. Dept. of Electrical Engineering, New York.

ON THE QUESTION OF MULTIPLE SCATTERING IN THE TROPOSPHERE, by D. S. Bugnolo. Nov. 19, 1959 [20]p. incl. diagrs. refs. (Technical rept. no. T-4/D; rept. no. CU-9-59AF350-EE) (AFOSR-TN-59-1252) (AF 49(638)350) AD 230877; PB 145555

Also published in Jour. Geophys. Research, v. 65: 879-884, Mar. 1960.

A criteria is developed to serve as a measure of multiple scattering in the troposphere as a result of dielectric noise. The question to be answered is: What is the probability that any ray of the incident field will be scattered at least twice in a distance R? This is a useful criteria in that it can be used as a measure of re-

liability for the usual single scatter approximations. The criteria is developed in detail for an arbitrary dielectric noise and applied to a number of special cases. The results indicate that multiple scattering effects should be of importance in the microwave spectrum. (Contractor's abstract)

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Columbia U. [Dept. of Electrical Engineering] New York.

MEAN-SQUARED-ERROR OF A BAND-LIMITED LONG LINE-OF-SIGHT RADIO LINK AFFECTED BY ATMOSPHERIC TURBULENCE (Abstract), by D. S. Bugnolo. [1959] [1]p. (AF 49(638)350)

Unclassified

Presented at meeting of the Internat'l. Scient. Radio Union, Pennsylvania State U., University Park, Oct. 20-22, 1958.

Published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 105-106, Jan. 1959.

One possible measure of system reliability in the presence of atmospheric turbulence is the notion of fidelity in a mean-squared sense. Given an arbitrary input $x(t)$ and the output $y(t)$, the fidelity is defined as

$$v = \frac{\overline{[x(t) - y(t)]^2}}{2}$$

This paper is concerned with the prediction of system fidelity as an application of the general theory of scattering for arbitrary inputs. The results are applied to the special case of a long line-of-sight radio link. It is shown that the fidelity in a mean-squared sense of a band-limited long line-of-sight radio link is directly proportional to the bandwidth.

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Columbia U. [Dept. of Mathematical Statistics] New York.

A NOTE ON PERFECT PROBABILITY, by G. Kallanpur. Feb. 1959 [8]p. (Rept. no. CU-46-59) (AFOSR-TN-59-210) (AF 18(600)442) AD 211664; PB 140417

Unclassified

Also published in Ann. Math. Stat., v. 30: 169-172, Mar. 1959.

A class of perfect probability spaces, called D-spaces, are defined and characterized. The triplet $(\Omega, \mathcal{Z}, \mu)$ is said to be a perfect probability space if μ is a probability over the σ algebra \mathcal{Z} of subsets of Ω and if for every univalent, real valued, \mathcal{Z} -measurable function f , the following is true: for every linear set A such that $f^{-1}(A) \in \mathcal{Z}$, there exists a linear Borel set B with $B \subseteq A$ and $\mu\{f^{-1}(B)\} = \mu\{f^{-1}(A)\}$. Proof is presented of the theorem giving a necessary and sufficient criterion for a D-space.

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Columbia U. [Dept. of Mathematical Statistics] New York.

ON THE INDEPENDENCE OF A LINEAR STATISTIC
AND OF A QUADRATIC STATISTIC, by G. Kallianpur.
[1959] 23p. (AFOSR-TN-59-211) (AF 18(600)442)
AD 262094 Unclassified

Let y_1, \dots, y_n be independent, identically distributed random variables. Consider the statistics $L = \underline{b}'\underline{y}$ and $Q = \underline{y}'\underline{A}\underline{y} + \underline{1}'\underline{y}$ where \underline{A} is the $n \times n$ matrix (a_{jk}) , $\underline{b} = (\underline{b}_1, \dots, \underline{b}_n)'$, $\underline{1} = (\underline{1}_1, \dots, \underline{1}_n)'$ and \underline{y} is the column vector with the y_j as components. In this paper the following problem is studied: under what conditions does the stochastic independence of L and Q imply the normality of \underline{y} ? Suppose the matrix \underline{A} and the vectors \underline{b} and $\underline{1}$ are connected by the following relations: $\underline{A}\underline{b} = \underline{0}$ and $\underline{1}'\underline{b} = 0$. (1) Let the diagonal elements of \underline{A} be all of the same sign and let at least one element a_{jj} be different from zero. Similarly let all the components of the vector \underline{b} be non-zero and of the same sign. Suppose further that for some $\rho > 0$ $E|y_1|^\rho$ is finite. If L and Q are independent statistics then \underline{y} is a normally distributed vector. (2) Let $a_{jj} = 0$ for $j = 1, \dots, n$ and suppose that the y_j are symmetric random variables with finite second moments. Then the independence of the statistics L and Q implies the normality of the y_j .

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Columbia U. Dept. of Physics, New York.

GROUND STATE A-DOUBLING TRANSITIONS OF OH RADICAL, by G. Ehrenstein, C. H. Townes, and M. J. Stevenson. [1959] [2]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)631], Office of Naval Research, and Signal Corps) Unclassified

Published in Phys. Rev. Ltrs., v. 3: 40-41, July 1, 1959.

The $F = 2 \rightarrow F = 2$ and $F = 1 \rightarrow F = 1$ transitions between the A-doubling levels of the lowest rotational level of the $2\pi_{3/2}$ electronic state of the OH radical, whose presence in interstellar space may be detectable by these lines in its radiofrequency spectrum, have been observed in the laboratory.

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Columbia U. [Electronics Research Labs.] New York.

THE EFFECT OF POLE AND ZERO LOCATIONS ON

THE TRANSIENT RESPONSE OF SAMPLED-DATA SYSTEMS, by E. I. Jury. [1955] [8]p. incl. diagrs. (AFOSR-3914) (AF 18(600)677) Unclassified

Presented at Winter General meeting of the Amer. Inst. Elec. Engineers, New York, Jan. 31-Feb. 4, 1955.

Also published in Trans. Amer. Inst. Elec. Engineers, v. 74 (Pt. II): 41-48, 1955.

The effect of the location of the poles and zeros of the transfer function of a sampled-data system on the location and magnitude of the maxima and minima of transient response resulting from a step function input is studied. Theorems are given relating to the necessary conditions for the production of monotonic and non-monotonic time response expressed in terms of pole and zero locations in the z-plane. It is shown that, under certain conditions of pole and zero locations, the normalized time-sequence response may well be approximated by a single dominant time term. A method is presented of ascertaining from the pole and zero location whether these conditions exist. On the basis of dominant term approx, the methods of synthesis applied to 2nd-order systems can be generally extended to general systems. The results of this investigation are directly applicable to the design problems in the field of pulsed networks and sampled-data control systems. (Contractor's abstract)

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Columbia U. [Electronics Research Labs.] New York.

CORRELATION BETWEEN ROOT-LOCUS AND TRANSIENT RESPONSE OF SAMPLED-DATA CONTROL SYSTEMS, by E. I. Jury. [1955] [8]p. incl. diagrs. (AFOSR-3915) (AF 18(600)677) Unclassified

Presented at Summer General meeting of the Amer. Inst. Elec. Engineers, Swampscott, Mass., June 27-July 1, 1955.

Also published in Trans. Amer. Inst. Elec. Engineers, v. 74 (Pt. II): 427-434, 1955.

The introduction of the root-locus method in the z-plane simplifies the investigation of sampled-data control systems, by demonstrating the correlation between transient response and the location of the roots. It is shown that by establishing the correlation between frequency locus and the root locus, the correlation between frequency and transient response of sampled-data systems can be demonstrated. Synthesis of sampled-data control systems can be performed in the time domain through the introduction of phase-angle loci as demonstrated in examples. Finally, approx equations are given so that transient overshoot and peak time may be evaluated without actually working out the transient solution. (Contractor's abstract)

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Columbia U. [Electronics Research Labs.] New York.

PULSE WIDTH MODULATED RELAY CONTROL OF SYSTEMS SUBJECT TO SAMPLED DATA, by W. L. Nelson. [1959] 68p. incl. diagrs. refs. (Technical rept. no. T-34/B) (AFOSR-TN-59-282) (AF 18(600)677) AD 212915; PB 142367 Unclassified

An investigation was conducted on the application of pulse width modulation as a control method for relay controlled systems with sampling. The limit cycles which occur in relay control systems with sampling are discussed, and 2 methods of design employing pulse width control which eliminate these limit cycles are developed. Experimental results are presented for a second order system. Application and extension of the results are discussed. (Contractor's abstract)

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Columbia U. [Electronics Research Labs.] New York.

PULSE WIDTH CONTROL OF SAMPLED DATA SYSTEMS, by W. L. Nelson. July 6, 1959, 149p. incl. diagrs. refs. (Technical rept. no. T-35/B; rept. no. CU-55-59AF677-EE) (AFOSR-TN-59-609) (AF 18(600)677) AD 217396; PB 143175 Unclassified

The use of pulse width control for the on-off regulation of systems subject to sampled data is investigated in this paper. The pulse width controller is considered to effect control of a linear n^{th} order plant by applying to the plant during each sampling period an input signal, selected from the restricted class of pulse width control signals, and based on the state of the plant at the sampling instant. The basic capabilities of this type of control are investigated in relation to simple on-off (or relay) control and in relation to pulse amplitude control. General methods for achieving both stable and optimal control are developed and practical design applications are considered. Examples and experimental evaluation of the design methods are also given. (Contractor's abstract)

382

Columbia U. [Electronics Research Labs.] New York.

A DIGITAL-ANALOG CONTROLLER FOR SAMPLED DATA SYSTEMS, by S. C. Bigelow. July 22, 1959, 47p. incl. illus. diagrs. (Technical rept. no. T-36/B; rept. no. CU-56-59AF677-EE) (AFOSR-TN-59-803) (AF 18(600)677) AD 226972; PB 143961 Unclassified

A practical digital controller is described for sampled data control systems. The controller is a hybrid digital-analog computer programmed to solve the control equations. The machine input and output signals are voltage analogs in the range of from -50 to +50 v.

Arithmetic operations are performed using analog computer circuits, while storage is accomplished in digital storage registers. Analog-to-digital and digital-to-analog conversions are performed internally. This controller serves a twofold purpose: (1) demonstrates the feasibility of applying the well-developed theory of sampled data control systems to real processes, and (2) provides a useful tool for further study of such systems. (Contractor's abstract)

383

Columbia U. [Electronics Research Labs.] New York.

A GENERAL FLOW GRAPH TECHNIQUE FOR THE SOLUTION OF MULTI-LOOP SAMPLED SYSTEMS, by R. Ash, W. H. Kim, and G. M. Kranc. July 31, 1959 [30]p. incl. diagrs. refs. (Technical rept. no. T-37/B; rept. no. CU-57-59-677-EE) (AFOSR-TN-59-824) (AF 18(600)677) AD 223400 Unclassified

A flow-graph approach for analyzing multi-loop sampled-data systems is presented. Two techniques for finding the sampled output are examined; these are: (1) construction of a sampled signal flow-graph from the original system; and (2) a general gain formula which can be directly applied to the original system. The theorems necessary to establish the formula are rigorously proven. The 1st technique allows 2 possible modes of solution. The sampled output can be found directly from the sampled flow graph by the use of Mason's formula, or in case of a more complicated multi-loop system, the problem of enumerating non-touching feed-back loops can be simplified by the use of topological matrices. Techniques developed are also applied to the solution of multirate systems. (Contractor's abstract)

384

Columbia U. [Electronics Research Labs.] New York.

OPTIMUM MULTIRATE CONTROLLER FOR A SAMPLED FEEDBACK SYSTEM, by G. M. Kranc. Oct. 1, 1959, 24p. incl. diagrs. (Technical rept. no. T-38/B; rept. no. CU-59-59AF677-EE) (AFOSR-TN-59-1095) (AF 18(600)677) AD 229686; PB 145100 Unclassified

An extension is made of optimum design procedures to sampled-data systems with a multirate controller used as a discrete compensator. The multirate controller is a discrete network which in response to input samples at time $t = 0, T, 2T, \dots$ produces output samples at time $t = 0, T/n, 2T/n, \dots$ (where n is an integer), any output sample being a linear combination of the past and present inputs and outputs. It is shown how to design this controller to achieve a least mean square continuous error with random inputs or a least integral continuous error with known test input functions. The advantages of the multirate controller over the single-rate compensator are demonstrated. (Contractor's abstract)

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Columbia U. [Electronics Research Labs.] New York.

SAMPLED DATA CONTROL SYSTEMS CONTAINING PERIODICALLY VARYING MEMBERS, by B. Friedland. Nov. 12, 1959, 25p. incl. diagrs. (Technical rept. no. T-39/B; rept. no. CU-60-59AF677-EE) (AFOSR-TN-59-1215) (AF 18(600)677) AD 230744; PB 145553
Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 1: 361-368, 1960.

The Z-transform method is extended to sampled-data systems containing periodically varying members. Every member is characterized by an $N \times N$ "transfer matrix" $H(z)$ whose elements are pulse transfer functions. The input-output relation for every member is given by $Y(z) = H(z) X(z)$ where $X(z)$ and $Y(z)$ are $1 \times N$ matrices (vectors) whose elements are the "skip-sampled Z-transforms" of the input and output, respectively. By the use of matrix algebra, the transfer matrices of the members are combined to obtain the overall transfer matrix of the system, from which the response of the system may be determined. The method is illustrated by application to the following problems: (1) multirate sampled systems; (2) systems in which samples are periodically omitted, and holding circuit with periodically varying hold time is employed; and (3) use of a periodically varying amplifier to achieve deadbeat performance.

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Columbia U. [Electronics Research Labs.] New York.

LINEAR MODULAR SEQUENTIAL CIRCUITS AND THEIR APPLICATION TO MULTIPLE CODING, by B. Friedland and T. E. Stern. [1959] [9]p. incl. diagrs. table. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)677 and Office of Naval Research under Nonr-26660) Unclassified

Presented at I.R.E. National Convention, New York, Mar. 23-26, 1959.

Also published in I.R.E. National Convention Record, Pt. 2: 40-48, 1959.

A linear modular sequential circuit (LMSC) is characterized by the relations (1) $y(n) = Cs(n) + Dx(n)$; (2) $s(n+1) = As(n) + Bx(n)$ in which $y(n)$, $x(n)$, and $s(n)$ are the input, output, and state vectors, respectively and A, B, C, D are matrices defined over the modular field $GF(p)$ ($p = \text{prime}$). Such circuits are useful in various types of sequential machines, and in particular in coding and decoding systems. Utilizing LMSC's systematic procedures for the construction of single error-correcting close-packed multiple level codes, in the manner of

D. A. Huffman, are given. The proper operation of the decoder is seen to depend upon certain periodic properties of powers of the matrix A. These properties are explored through the use of the theory of finite fields, and appropriate synthesis procedures are derived. (Contractor's abstract)

387

Columbia U. Inst. of [Air] Flight Structures, New York.

VIBRATIONS AND STABILITY OF PLATES UNDER INITIAL STRESS, by G. Herrmann and A. [E.] Armenakas. Feb. 1959 [51]p. incl. diagrs. table, refs. (Technical note no. 1; rept. no. CU-2-59AF430-CE) (AFOSR-TN-59-189) (AF 49(638)430) AD 211220; PB 140561
Unclassified

Several linear theories of motion of elastic plates are established which in addition to initial membrane forces take into account initial moments and transverse shear forces. The equations of motion are obtained by linearizing the appropriate nonlinear plate equations and, in the absence of initial stresses, they are reduced, depending upon the order of approximation, to either the classical (elementary) or the Mindlin plate theory (classical theory including the effects of shear deformation and rotatory inertia). These equations are applied to the solution of particular problems, and the effect of uniform initial compression, bending moment and transverse shear force on the frequencies of the flexural, longitudinal, thickness-shear and the first 2 face-shear models are discussed. In the course of this investigation it was found that a plate may buckle under a uniform initial transverse shear force in a similar fashion as under initial compression. (Contractor's abstract)

388

Columbia U. Inst. of [Air] Flight Structures, New York.

ENERGY METHODS FOR THE ANALYSIS OF TEMPERATURE DISTRIBUTIONS AND THERMAL STRESSES IN STRUCTURES, by G. Herrmann. May 1959, 12p. (Technical note no. 2; rept. no. CU-4-59AF-430-CE) (AFOSR-TN-59-327) (AF 49(638)430) AD 213675; PB 140994
Unclassified

Some well-known energy theorems of structural analysis are generalized for the case when a part of the stresses is due to thermal effects. These methods assume that the temperature distribution is known. It is shown further that the temperature distribution in the structure itself may be determined by the use of analogous energy theorems, which can be established for both steady-state and transient conditions. (Contractor's abstract)

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Columbia U. Inst. of [Air] Flight Structures, New York.

SHEAR BUCKLING OF BARS, by G. Herrmann and A. E. Armenakas. Oct. 1959 [11]p. incl. diagrs. (Technical note no. 3; rept. no. CU-7-59 AF430-CE) (AFOSR-TN-59-1016) (AF 49(638)430) AD 228828; PB 144762
Unclassified

Also published in Jour. Appl. Mech., v. 27: 455-457, Sept. 1960.

It is shown that a perfectly straight bar, subjected to a state of uniform shear stress will buckle, in a manner similar to a column under compression, if the shear stress exceeds a certain critical value. The buckling equations are obtained by the Newtonian approach, and also by the application of the principle of minimum potential energy. In order to provide additional insight into this buckling mechanism, a simple model is introduced and analyzed. (Contractor's abstract)

390

Columbia U. [School of Engineering] New York.

TWINNING IN ZINC SINGLE CRYSTALS, by H. D. Guberman. Aug. 31, 1958, 27p. incl. diagrs. tables. (AFOSR-TN-59-269) (AF 18(600)898, Task I) AD 212703; PB 142023
Unclassified

Resolved shear stresses for the nucleation of twins in the range 892 gr/mm² to 2317 gr/mm² have been found for clean surfaced zinc single crystals. For coated crystals the resolved shear stresses lay in the range 862 gr/mm² to 2568 gr/mm². The results are interpreted as supporting the views of Bell and Cahn (Proc. Roy. Soc. (London), v. 239A: 494, 1957) concerning the nucleation of twins in zinc single crystals. (Contractor's abstract)

391

Columbia U. [School of Engineering] New York.

[AN INVESTIGATION OF THE NATURE OF FRACTURE IN METALS] by D. N. Beshers. [Final rept.] Aug. 31, 1958, 7p. (AFOSR-TR-59-90) (AF 18(600)898; Task I)
Unclassified

A summary and evaluation of work completed under this contract is presented. The results include the verification that twin interfaces and incoherent surface coatings greater than 300A are effective barriers to dislocations, producing pileups that can lead to fracture. One way in which twins can affect the fracture properties of zinc is demonstrated. Also studied was a determination of whether the absolute grain size or the number of grains in a cross sectional area is controlling factor in determining flow and fracture stresses of metals at low temperatures.

392

Columbia U. [School of Engineering] New York.

INTERNAL FRICTION STUDY OF COLD WORKED IRON CONTAINING NITROGEN, by D. Petarra. [1959] 28p. incl. diagrs. tables. (AFOSR-TN-59-270) (AF 49(638)-408) AD 212704; PB 142004
Unclassified

A mechanism explaining the complex behavior 220°C peak height as a function of annealing temperature has been advanced. It has been shown that the recovery process directly affects the height of the 220°C internal friction peak, and indirectly affects the height of the room temperature internal friction peak. The intimate relationship between these 2 peaks is brought out. (Contractor's abstract)

393

Columbia U. [School of Mines] New York.

GRAIN BOUNDARY SLIDING AND INTERCRYSTALLINE CRACKING, by J. Intrater and E. S. Machlin. [1959] [4]p. incl. illus. diagrs. [AF 18(600)965]
Unclassified

Published in Acta Metall., v. 7: 140-143, Feb. 1959.

The results of this study concerned with grain boundary sliding and intercrystalline cracking are as follows: (1) Grain boundary sliding along stationary grain boundaries will lead to the formation of voids situated along these grain boundaries. (2) The number of voids produced increases monotonically with the amount of grain boundary sliding independent of the temperature. (3) Vacancy condensation and any other thermally activated process, as a mechanism for the primary nucleation and growth of voids, is unimportant under these experimental conditions. (4) Upon testing of hydrogen the voids are isolated. With a vacuum of 5×10^{-4} mm Hg the voids are better described as cracks. (5) The number of voids produced per unit of grain boundary area is sensitive to the grain boundary morphology and jog population.

394

Columbia U. [School of Mines] New York.

A METHOD FOR GROWING BICRYSTALS OF COPPER, by J. Intrater and E. S. Machlin. [1959] [2]p. incl. diagrs. [AF 18(600)965]
Unclassified

Published in Trans. Metall. Soc. AIME, v. 215: 471-472, 1959.

The method reported in this technical note explains its availability for a study on grain boundary sliding in superpure copper using bicrystals of a specific shape. The bicrystals are comprised of single crystals of 2

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different orientations grown from the melt in 1/2 of a split graphite mold. The 2 crystals were remelted starting 2 in. from the top to insure that the whole top portion of the crystal was maintained molten. A bicrystal was obtained by moving the induction coil vertically upward at a speed of 1 in./hr. It was found that tapered inserts were necessary to minimize the strain at the contracted section of the bicrystals during solidification.

395

Combustion and Explosives Research, Inc., Pittsburgh, Pa.

COMBUSTION, FLAMES AND EXPLOSIONS OF GASES, by B. Lewis and G. von Elbe. New York, Academic Press, 1961, 731p. incl. illus. diags. tables, refs. (AFOSR-TR-59-209) (AF 49(638)307) Unclassified

The mass of material concerned with combustion research is accumulated for presentation, interpretation and authoritative application of theoretical aspects pointing the way to the solution of many problems. Particular emphasis is placed on the modification of combustion wave propagation due to heat loss to the unburned medium and to localized changes of mixture composition by diffusional processes.

396

Combustion Inst., Pittsburgh, Pa.

SEVENTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, 959p. incl. illus. diags. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)316], Office of Naval Research, and Office of Ordnance Research) Unclassified

This symposium was the 1st in the series (see also item nos. PIT.01:001, Vol. I and CIP.01:001, Vol. II) to be held outside of the United States and the 1st at which preprints of accepted papers were supplied to participants. There were 18 technical sessions, each lasting about 100 minutes. Approximately 120 papers were presented, covering topics such as detonation, the spectroscopy and structure of flames, the mechanism of combustion reactions, ionization in flames, the interaction of flames with surfaces, the mechanism of flame propagation, turbulence in flames, ignition and limits of inflammability, combustion in practical flowing system, special fuels, and instrumentation. Twenty countries were represented at the symposium.

Committee on Mathematical Biology, Chicago, Ill. see Chicago U. Committee on Mathematical Biology, Ill.

397

Compagnie Generale de Telegraphie Sans Fil, Paris (France).

RESEARCH ON RECOMBINATION PROCESSES IN SEMI-CONDUCTOR. Final technical rept. [1959] 8p. incl. diagr. (AFOSR-TR-59-37) (AF 61(052)100) AD 230185; PB 145039 Unclassified

A summary is given of the experiments based on the emission of infra-red radiation from the recombination of hole-electron pairs in the semi-conductors germanium and silicon, especially at low or very low temperatures.

398

Copenhagen U. Inst. of Neurophysiology (Denmark).

CENTRAL NERVOUS MECHANISMS IN COLOR VISIONS, by M. A. Lennox. [1959] [2]p. incl. diags. (AFOSR-TN-59-298) (AF 61(514)1194) AD 213082 Unclassified

Also published in Danish Med. Bull., v. 5: 164-165, June 1958.

Studies were carried out on cats to determine what happens in the brain when the color of a light is changed. Responses from the cortex were recorded when the eye was flashed with blue, green, yellow, and red light. At high intensities the response occurred earlier when the light was red, later when yellow, and latest when blue or green. It was also found that 2 mechanisms were at work: (1) the red light caused a faster photochemical reaction in the eye, and (2) the red-sensitive receptors were connected with large fibers which conducted the impulse faster in the central nervous system.

399

Copenhagen U. Inst. of Neurophysiology (Denmark).

STUDY OF THE ORGANIZATION OF THE VISUAL SYSTEM IN RESPECT TO COLOR, by M. A. Lennox. Final technical rept. Jan. 1-Dec. 31, 1958, 9p. (AFOSR-TR-59-34) (AF 61(514)1194) AD 213037; PB 142099 Unclassified

An attempt was made to test the hypothesis that conduction velocity might be the central basis of color discrimination. Flashes of 5 different colors at equal intensity were delivered to the eye of a monkey. The color filters transmitted broadly, 50 mμ at 1% transmission, and had peak transmissions at above 600, at 580, 560, 510 and 450 mμ. Three types of cortical cells were found; those with selective spectral sensitivity responding to 1 or at most 2 colors; those responding to all colors; and cells responding not at all to light whether the eye were dark adapted or in light. The response to optic nerve stimulation was of 2 types. Some cells responded with 1 or 2

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spikes with no significant change in latency irrespective of the stimulus, indicating that these cells were fired by 1 radiation fiber. Other cells responded with a burst of spikes and the latency of this burst decreased with increasing stimulus intensity, which indicated overlap or convergence of a number of radiation fibers on the single cell. These cells tended to respond to all colors. A few cells responded to optic nerve stimulation, but not to any of the colors used. One cell responded to changes in background illumination and to optic nerve stimulation but not to color flash.

400

Copenhagen U. Inst. of Neurophysiology (Denmark).

SINGLE UNIT OFF RESPONSES TO BRIEF FLASHES IN CAT'S OPTIC TRACT, by M. A. Lennox. [1959] [10]p. incl. diagrs. tables, reis. (Technical scientific note no. 1) (AFOSR-TN-59-674) (Sponsored jointly by Air Force Office of Scientific Research under AF 61-(052)189 and Danish State Research Foundation) AD 218386 Unclassified

Also published in Jour. Neurophysiol., v. 22: 88-97, Jan. 1959.

In cats a microelectrode was used to record from single fibers in the optic tract when the opposite eye was flashed with blue or red light and when the optic nerve was stimulated electrically. Three types of off unit were found. (1) Intensity sensitive units. The number of spikes was determined by the amount of light, whether this was altered by changing the intensity or the duration of the flash. (2) Units not sensitive to intensity in which the number of spikes after cessation of the flash either in off or on-off units was not regulated by the amount of light. (3) Mixed forms. There was no correlation between the off discharge and the color of the light, nor with conduction velocity along the fiber. (Contractor's abstract)

401

Copenhagen U. Inst. of Neurophysiology (Denmark).

RESPONSES TO MONOCHROMATIC FLASHES OF SINGLE CELLS IN MONKEY CORTEX, by M. A. Lennox. [1959] 9p. (AFOSR-TN-59-1318) (AF 61(052)-189) Unclassified

Presented at meeting of the Society for Experimental Biology, Copenhagen (Denmark), Aug. 14, 1959.

A study designed to see what correlations there may be between fiber size, that is conduction velocity in the optic nerve and radiations, and response to color is reported. It is pointed out that the anesthesia used on the adult Mangabeys from Africa raises their threshold to light and that certain quantitative adjustments might have to be made. Half the cells encountered responded to light flash or optic nerve stimulation. Certain cells

responded only to light at 580 mμ flashes, yet there are no known retinal cells with such a narrow spectral sensitivity. This suggests that the nervous interaction at some point along the visual pathway makes the differentiation. Single cortical cells which respond reliably to 1 and only 1 of the colors used were found. There are also cells which respond to 2 or 3 spectrally adjacent colors when there is a background illumination on the eye. In the dark, cells respond to all colors with increasing vigor and diminishing threshold as the dark period becomes more prolonged. This supports the common assumption that the activity of the rods is inhibited in the presence of light, and also suggests that the activity of the cones may be inhibited in the dark.

402

Cork U. Coll. (Ireland).

CURVE FITTING AND INTEGRAL CURVES FOR NON-LINEAR DIFFERENTIAL EQUATIONS. A GENERALISED STEP-FUNCTION APPROACH, by P. M. Quinlan. Sept. 1958, 37p. incl. tables. (Technical note no. 5) (AFOSR-TN-59-65) (AF 61(514)1163) AD 209609; PB 139604 Unclassified

Generalized step-functions are used to give a curve of any specified degree of continuity passing through specified points. The method is extended so that the slope and ordinate of the fitting curve are equal to those of a given curve. A calculus is developed for matching both ordinate-slope and curvature at all points of regular subdivision by a generalized step function expression. The necessary calculus for differentiation, integration, including repeated integration, and interpolation is developed. An estimate of the accuracy of the various fits is obtained by evaluating the standard integral $\cos x$, and it is shown that the ordinate-slope method is unaffected by either points of inflection or critical points. The ordinate-slope and the ordinate-slope-curvature methods are used as the basis of a new method of finding integral curves for differential equations, including non-linear equations. (Contractor's abstract, modified)

403

Cork U. Coll. (Ireland).

VIBRATION OF BEAMS - A RECURRENCE APPROACH, by P. M. Quinlan. Sept. 1958, 35p. incl. diagrs. tables. (Technical note no. 6) (AFOSR-TN-59-118) (AF 61(514)-1163) AD 210423; PB 139617 Unclassified

A new method is presented for obtaining the frequencies of vibration of a loaded beam. The usual frequency determinant is by-passed, and the frequency equation is obtained by the multiplication of 2 sets of polynomials. Thus the higher critical frequencies can be obtained as readily as the lowest frequency, an advantage not possessed by any existing method. The method is developed in 4 stages by the aid of graded examples, beginning with the simple case of a light beam under a concentrated

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central load, then going onto a beam under 2 loads when the avoidance of a frequency determination is possible due to successive elimination. Next application is made to a non-uniform beam, in which the necessary calculus is developed, and then in the 4th example, an aircraft wing, the development culminates in a systematic self-checking tabular method based on a recurrence relation between the amplitudes v_r at point x_r . In the concluding section application is made to the torsional oscillations of a shaft under 6 masses. (Contractor's abstract)

404

Cork U. Coll. (Ireland).

HYPERCIRCLE METHOD APPLIED TO THE SOLUTION OF THE BIHARMONIC EQUATION. II, by V. G. Hart. Dec. 1958, 20p. incl. diagrs. (Technical note no. 7) (AFOSR-TN-59-296) (AF 61(514)1163) AD 213040; PB 142019 Unclassified

The approximate solution of the biharmonic equation is considered in a plane multiply connected region. The boundary conditions correspond to the problem of a perforated elastic plate clamped at both interior and exterior boundaries and subjected to transverse loading. The method used is that of the hypercircle, and it provides upper and lower bounds on a functional (the strain-energy) involving the solution of the biharmonic boundary-value problem. Pointwise bounds are not considered here, but can be obtained by use of a suitable Green's function. Estimates of the deflection of the plate and bending moments in it are also given. As an illustration of the method, the problem of an elastic plate in the shape of a hollow square is considered. A preliminary and a higher approximation are described. Unfortunately due to the poor condition of the digital computer available, only 1 bound could be supplied in the latter approximation. (Contractor's abstract)

405

Cork U. Coll. (Ireland).

RESEARCH ON TORSION AND PLATE PROBLEMS, by P. M. Quinlan. Annual summary rept. no. 1, Dec. 1, 1956-Nov. 30, 1958. Jan. 6, 1959, 8p. (AFOSR-TN-59-297) (AF 61(514)1163) AD 213081; PB 140814 Unclassified

A synopsis is given of the research on torsion and plate problems with special reference to conformal mapping and the hypercircle method. The research is reported in a series of 7 technical notes. The mathematical solution is investigated for the hexagon, eccentric circular cylinder, oblate and prolate, and semi-elliptical sections using conformal mapping. The application of Fourier integral method and the hypercircle method are investigated for a semi-infinite plate, fixed horizontally along its edges, and for plates with holes, respectively. The hypercircle method is applied to multiply connected plates and the skew-bridge problem. Problems in elas-

ticity are investigated with special reference to problems having anisotropic elasticity. The problem of programming is investigated for resulting nonlinear equations. (ASTIA abstract, modified)

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Cork U. Coll. (Ireland).

FOURIER SERIES FOR TWO-POINT BOUNDARY-VALUE PROBLEMS, by P. M. Quinlan. Nov. 1959, 1v. incl. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-59-744) (AF 61(514)1163) AD 233280 Unclassified

The general solution of the differential equation $F(D^2)z = g(x)$ is obtained in the form of a Fourier Sin or Cos Series. The result is expressed in terms of Fourier-Sum Functions, involving 2 parameters K and Θ which are tabulated for $K, O(.1)2$; $\Theta/\pi, O(.1), 1$. The method is illustrated by numerical application to an 8 order differential equation. (Contractor's abstract)

407

Cork U. Coll. (Ireland).

A PROPERTY OF BOUNDED REGULAR FUNCTIONS, by P. B. Kennedy. [1959] 15p. (Technical note no. 4) (AFOSR-TN-59-669) (AF 61(514)1399) AD 218381; PB 143168 Unclassified

Also published in Proc. Roy. Irish Acad., v. 60A: 7-14, 1959.

For a bounded regular function $f(z)$ in the unit circle $|z| < 1$, an investigation is made of the relation between the growth of the Nevanlinna characteristic of the derivative of f and the angular measure of the set of singularities of f on $|z| = 1$.

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Cork U. Coll. (Ireland).

ON A CLASS OF FUNCTIONS REGULAR AND BOUNDED IN THE UNIT CIRCLE, by P. B. Kennedy. [1959] 16p. (Technical note no. 5) (AFOSR-TN-59-670) (AF 61(514)1399) AD 218382; PB 143167 Unclassified

Examples are constructed to shed light on the "goodness" of the hypothesis under which $f \in Q$ implies $f' \in Q$. The condition essential to the truth of Hayman's theorem is shown. It is also pointed out that some "order-of-contact condition" occurring in the definition of "properly contains" is needed.

409

Cork U. Coll. (Ireland).

THE ABSOLUTE CONVERGENCE OF CERTAIN LACUNARY FOURIER SERIES, by S. O'Shea. [1959] [12]p. (Technical note no. 6) (AFOSR-TN-59-883) (AF 61-514)1399 AD 226388; PB 146100 Unclassified

Also published in Proc. Roy. Irish Acad., v. 61A: 1-8, 1960/61.

Let $f(x)$ be measurable and periodic with period 2π , and satisfy a uniform Lipschitz condition of order α ($0 \leq \alpha \leq 1$) in every finite interval. Let the Fourier

series of f be $\frac{1}{2}a_0 + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$. Results

for the cases $0 < \alpha \leq \frac{1}{2}$ are interpolated between the following 2 theorems: (1) if $\alpha > \frac{1}{2}$, then $\sum (|a_n| + |b_n|) < \infty$; and (2) if $\alpha = 0$ and $a_n = b_n = 0$ except possibly for $n = n_k$, where $\{n_k\}$ is a sequence of positive integers satisfying $\liminf_{k \rightarrow \infty} \frac{n_{k+1}}{n_k} > 1$, then $\sum (|a_n| + |b_n|) < \infty$ is true. (ASTIA abstract)

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Cork U. Coll. (Ireland).

RESEARCH ON PROPERTIES OF THE COEFFICIENTS IN FOURIER SERIES WITH GAPS, by P. B. Kennedy. Final technical rept. June 15, 1959 [7]p. incl. refs. (AFOSR-TR-59-115) (AF 61(514)1399) AD 226390; PB 145276 Unclassified

Size of coefficients in lacunary Fourier series of functions with certain continuity properties are presented; some questions of convergence of such series are raised; applications in regular-function theory are suggested.

411

Cork U. Coll. (Ireland).

ON A DIVERGENT TRIGONOMETRICAL SERIES GIVEN BY STEINHAUS, by S. O'Shea. [1959] [3]p. (AF 61(514)1399) Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 68-70, Feb. 1959.

Steinhaus gave the series

$$(*) \sum_{n=2}^{\infty} (\log n)^{-1} \cos n(x - \log \log n)$$

as an example of an everywhere divergent trigonometric series with coefficients tending to zero. The author shows that a condition on $u(n) \uparrow \infty$ and $c_n \downarrow 0$ sufficient

that $\sum_{n=1}^{\infty} c_n \cos(nu(n)) \cos nx$ should diverge for all

real x is the existence of a sequence of positive integers p_n such that $\limsup_{n \rightarrow \infty} (n + p_n)[u(n + p_n) - u(n)] < \frac{1}{2}$ and

$$\liminf_{n \rightarrow \infty} \sum_{m=n+1}^{n+p_n} c_m > 0. \text{ The special case } u(n) =$$

$\log \log n$, $c_n = (\log n)^{-1}$, $n \geq 2$, gives the "cosine part" of (*). The condition is also sufficient that

$\sum_{n=1}^{\infty} c_n \sin(nu(n)) \sin nx$ should diverge for all $x \neq 0 \pmod{\pi}$. (Math. Rev. abstract)

412

Cork U. Coll. (Ireland).

ON A THEOREM OF HAYMAN CONCERNING QUASI-BOUNDED FUNCTIONS, by P. B. Kennedy. [1959] [8]p. (AF 61(514)1399) Unclassified

Published in Canad. Jour. Math., v. 11: 593-600, 1959.

Let $f(z)$ be regular in $|z| < 1$. If $m(r, f) =$

$$(2\pi)^{-1} \int_{-\pi}^{\pi} \log^+ |d(re^{i\theta})| d\theta \text{ is bounded for } 0 < r < 1,$$

$f(z)$ is called quasi-bounded. Hayman (Rend. Circ. Mat. Palermo, Series 2, v. 2: 346-392, 1953) has given conditions that $f'(z)$ be also quasi-bounded. A domain D is said to properly contain a sequence of non-overlapping open arcs (1) $z = e^{i\theta}$, $\theta_n < \theta < \theta_n + \delta_n$ ($n = 1, 2, 3, \dots$), if the distance $d(\theta)$ from $e^{i\theta}$ to the boundary of D satisfies $d(\theta) > A(\theta - \theta_n)(\theta_n + \delta_n - \theta)^B$, ($A > 0$, $B > 0$ constants).

Hayman showed that if D contains $|z| < 1$ and properly contains the sequence of arcs (1) such that

$$(2) \sum_{n=1}^{\infty} \delta_n = 2\pi, \sum_{n=1}^{\infty} \delta_n \log \frac{1}{\delta_n} < \infty, \text{ and if } f(z) \text{ is regular}$$

and bounded in D , then $f'(z)$ is quasi-bounded in $|z| < 1$. The author shows that if the inequality in (2) is replaced

$$\text{by } (3) \limsup_{n \rightarrow \infty} (\sum_{j=1}^n \delta_j) \log \frac{1}{\delta_n} = \infty, \text{ then } m(r, f') \sim \infty \text{ as}$$

$r \rightarrow 1$. In particular, the inequality in (2) cannot in general be replaced by (4) $\sum_{n=1}^{\infty} \delta_n (\log \frac{1}{\delta_n})^{\alpha} < \infty$, for any $\alpha < 1$. (Math. Rev. abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE TAILORED-INTERFACE HYPERSONIC SHOCK TUNNEL, by C. E. Wittliff, M. R. Wilson, and A. Hertzberg. Mar. 1958, 1v. incl. illus. diagrs. refs. (AFOSR-TN-59-31) (AF 18(603)10) AD 209203 Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Presented at ASME-ARS Aviation Conf., Dallas, Tex., Mar. 16-20, 1958.

Also published in Jour. Aero/Space Sci., v. 26: 219-222, Apr. 1959.

During recent years, the shock tunnel has come into widespread use as a hypersonic test facility. It has been found that strong shock waves in large length-to-diam ratio shock tubes undergo severe attenuation resulting in unsteady flow conditions in the test section. A new design, termed the "tailored-interface" shock tunnel, has been developed which increases the testing time up to 25 times that of the conventional shock tunnel of the same length alleviating the attenuation problem. The results of heat transfer experiments on a hemisphere-cylinder model are presented and compared with theory, wind-tunnel and free flight data. (Contractor's abstract)

414

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

BOUNDARY-LAYER DISPLACEMENT AND LEADING-EDGE BLUNTNESS EFFECTS IN HIGH TEMPERATURE HYPERSONIC FLOW, by H. K. Cheng, J. G. Hall and others. Jan. 1959 [81]p. incl. illus. diagrs. tables, refs. (Rept. no. AD-1052-A-9) (AFOSR-TN-59-1193) (AF 18(603)10) AD 233867; PB 146370

Unclassified

Presented at Twenty-eighth annual meeting of the Inst. Aeronaut. Sci., Hypersonic Phenomena Session, New York, Jan. 25-27, 1960.

Also published in Jour. Aero/Space Sci., v. 28: 353-382, May 1961.

Two important features of hypersonic flow over slender or thin bodies are given; these are: (1) the displacement effect of the boundary layer and (2) the large downstream influence of leading-edge bluntness. New theoretical and experimental results on this problem are given. The interaction of the 2 effects is treated theoretically by extending the basic shock-layer concept. A detached shock layer is introduced to account for bluntness. In the boundary-layer, the approximate solution is found to be governed by local similarity. For the specific heat ratio α close to unity, the leading approximation for flat-plate afterbodies yields a solution agreeing with blast-wave theory at 1 limit and strong-interaction theory at the other. Similarly, flow over a blunted wedge is treated. A hypersonic similitude involving strong shocks, but not requiring α close to 1 is also given. The solutions obtained in the leading approximation provide a natural comparison with experimental data correlated on the basis of this similitude. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

GASDYNAMICS OF A WAVE SUPERHEATER FACILITY FOR HYPERSONIC RESEARCH AND DEVELOPMENT, by R. C. Weatherston, W. E. Smith and others. Feb. 1959, 133p. incl. diagrs. tables, refs. (Rept. no. AD-1118-A-1) (AFOSR-TN-59-107) (AF 18(603)141) AD 210220; PB 142603

Unclassified

The fundamental principles of wave superheater design and operation are developed. The gasdynamic and heat transfer aspects of one version, which is designed to generate 9000°R in uncontaminated air, are discussed. A prototype wave superheater was built and operated successfully at its designed conditions of 3000°R in air and 5500°R in Ar, starting from room temperature (COA.02:003, Vol. II). The 9000°R superheater utilizes preheated He driver and preheated test gases, and can superheat 4.3 lb of uncontaminated air/sec at 200 atm stagnation pressure. Ar can readily be substituted for air as a test gas and superheated to 17,000°R at the rate of 12 lb/sec. Cooling of the superheater structure and the effects of heat transfer within the superheated air are examined. Certain shock tube experiments were performed to test the nonsteady heat transfer theory. (Contractor's abstract, modified)

416

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

ENGINEERING DESIGN OF A WAVE SUPERHEATER FACILITY FOR HYPERSONIC RESEARCH AND DEVELOPMENT, by J. E. Carpenter. Feb. 1959, 1v. incl. illus. diagrs. tables, refs. (Rept. no. AD-1118-A-2) (AFOSR-TN-59-108) (AF 18(603)141) AD 210224; PB 145085

Unclassified

The engineering problems associated with the development of the 9000°R Wave Superheater are presented in considerable detail. Included are the approaches that were pursued to attain a sound solution and the reasons for selecting the final engineering configurations. The major portion of the report is concerned with equipment selection and the background of engineering information required to perform the selection. Several appendices are included which report in detail the results of various analytical and experimental studies. Specifications for the major items of purchased equipment are also included. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

BOUNDARY-LAYER TRANSITION AND HEAT TRANSFER IN SHOCK TUBES, by R. A. Hartmanian, A. L. Russo, and P. V. Marrone. May 1959, 31p. incl. illus. diagrs. refs. (Rept. no. AD-1118-A-3) (AFOSR-TN-59-564) (AF 18(603)141) AD 234728; PB 146973

Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in Jour. Aero/Space Sci., v. 27: 587-594, Aug. 1960.

An experimental study was made of the wall boundary layer in a shock tube operated over a wide range of shock Mach numbers and pressure levels in air, including those for which real gas effects exist. Transition distances are determined, and correlated in terms of the transition Reynolds number based on a characteristic length for this boundary layer. Data from independent shock-tube studies are also included in this correlation. The results indicate a weak dependence of transition Reynolds number on shock strength up to moderate values of shock Mach number, followed by a larger stabilizing tendency. Comparison of these data with transition data obtained in the same manner in argon indicate that the increased cooling rates are largely responsible for the stabilization. A dependence of transition Reynolds number on the unit Reynolds number is found at the lower shock strengths. Specifically, higher transition Reynolds numbers are achieved at larger unit Reynolds numbers. The phenomenon of transition reversal does not appear within the range of the experiments reported. Laminar and turbulent flow heat transfer rates to the walls of the shock tube are determined experimentally. The results of the heat transfer measurements substantiate existing theories in both the laminar and turbulent flow regimes. (Contractor's abstract)

418

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE HYPERSONIC AERODYNAMICS OF SLENDER AND LIFTING CONFIGURATIONS, by F. K. Moore and H. K. Cheng. [1959] 47p. incl. diagrs. refs. (AFOSR-TN-59-599) (AF 16(603)141) AD 221896
Unclassified

Also published in Inst. Aerospace Sci. First Award Papers, 1959, p. 59-125.

A review is made of the theory of hypersonic aerodynamics, having in mind application to slender and lifting configurations. Within the framework of hypersonic small-perturbation theory, the effects of leading edge bluntness and shock-layer-boundary-layer interaction are discussed, and the limitations of the theory are described. New experimental results for the interaction process on a cold flat plate at $M = 12$ are cited. The idea of local boundary-layer similarity is discussed in terms of application to slender configurations. The consistent development of shock-layer theory assuming a ratio of specific heats near 1 and a very strong shock is described, incorporating the local-similarity theory of the laminar boundary layer. The special case of a cone at angle of attack is discussed in some detail, and an explicit description of the entropy sublayer which is a general feature of such problems is included. The secondary flow in the hypersonic boundary layer is evaluated, and is found to be important for slender cones. In the light of information ob-

tained concerning the cone at angle of attack, the corresponding shock-layer theory for more general pointed bodies is outlined. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE PERFORMANCE OF THIN-FILM THERMOMETERS IN PARTIALLY IONIZED SHOCK-TUBE FLOWS, by P. V. Marrone and R. A. Hartunian. Nov. 1959 [7]p. incl. diagrs. (Rept. no. AD-1118-A-5) (AFOSR-TN-59-1046) (AF 18(603)141) AD 229133

Unclassified

Also published in Phys. Fluids, v. 2: 719-721, Nov.-Dec. 1959. (Title varies)

In shock-tube study of the processes of boundary layer transition and heat transfer at high temperatures conducted with thin-film resistance thermometers, it was found that the presence of very small degrees of ionization in the shocked gas induced spurious electrical signals in the output of the thin-film gauge. The techniques employed in overcoming this difficulty are discussed. The use of a thin insulative coating of SiO_2

proved to be the most successful of the several techniques investigated. SiO was evaporated directly over the Pt element to a thickness of 800-1000 Å. The gauge was then fired in an oven for approximately 9 hr at 1000°F to convert the SiO to SiO_2 . Results show that:

- (1) the SiO_2 coated gauge performed satisfactorily in highly ionized gases, permitting studies of heat transfer in high temperature flow, (2) the increase in rise time due to the SiO_2 layer is very small, the total rise time being approximately 2μsec, and (3) this technique makes it possible to apply foils over the SiO_2 coating, with small increase in rise time, permitting the study of surface chemistry effects on heat transfer.

420

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

PRELIMINARY RESEARCH ON A MOLECULAR BEAM FOR THE 1-10 EV RANGE, by G. T. Skinner and C. E. Treanor. Dec. 1959, 61p. incl. illus. diagrs. table, refs. (Rept. no. AD-1118-A-9) (AFOSR-TN-59-1086) (AF 18-(603)141) AD 236369; PB 147406
Unclassified

An interim discussion is given of the design and construction of a molecular-beam apparatus for the production of atomic and molecular beams in the 1-10 ev energy range. A shock tube is used as the source of high-temperature, high-pressure gas, and a hypersonic expansion is used to obtain a high-energy, nearly-monoeenergetic beam. Use of a two-center potential for the treatment of atom-molecule collisions is discussed. (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

HEAT TRANSFER FROM DISSOCIATED GASES IN A SHOCK TUBE, by R. A. Hartunian and P. V. Marrone. Nov. 1959, 72p. incl. diagrs. tables, refs. (Rept. no. AD-1118-A-7) (AFOSR-TN-59-1087) (AF 18(603)141) AD 234379
Unclassified

Measurements of the heat transfer from dissociated oxygen to the side-wall of a shock tube were made over a wide range of operating conditions using the methods of thin-film thermometry. Numerical solutions of the equilibrium shock-tube wall boundary-layer equations for several values of the Lewis number were obtained. Results show the heat transfer to be very weakly dependent upon the Lewis number. This indicates the shock-tube wall boundary layer to be a source for experimental determinations of the viscosity coefficient of dissociated gases. Experimental data obtained in the equilibrium boundary-layer regime agree with the theory at the low temperatures, and rise above the theoretical curves at the higher temperatures. This difference between theory and experiment is attributed to the uncertainty in the calculated viscosity coefficient used in the theory. The experiments were then used to determine new values for the viscosity coefficient of high temperature, dissociated oxygen. These values are considerably higher than those predicted theoretically using a Lennard-Jones potential or Sutherland's formula. Techniques are described by which thin-film thermometers can be used to measure heat transfer from ionized gases and, also, to study the effects of surface catalytic efficiency on the heat transfer from dissociated gases. The results of exploratory experiments using the latter technique are discussed. The results of calculations are presented which illustrate the reductions in heat transfer to the stagnation point of re-entering vehicles that may be achieved through the use of a noncatalytic surface. (Contractor's abstract)

422

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

A GRAPHICAL SOLUTION OF SHOCK EQUATIONS, by C. E. Treanor and M. J. Williams. Nov. 1959, 32p. incl. diagrs. (Rept. no. AD-1118-A-4) (AFOSR-TN-59-1088) (AF 18(603)141) AD 230216; PB 144909
Unclassified

A rapid graphical method for calculating the conditions behind a normal shock is described. The method applies to any gas for which the enthalpy is known as a function of pressure and density. The accuracy is limited only by that of the available graph of the gas properties. The necessary working graphs for air, O_2 and

N_2 (complete thermodynamic equilibrium) and for NO (without chemical reaction) are included, along with a template for use in attaining the solution (Contractor's abstract)

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SPECTROSCOPIC TECHNIQUE FOR TEMPERATURE-DENSITY MEASUREMENTS IN OXYGEN-BEARING FLOWS, by W. H. Wurster and C. E. Treanor. Dec. 1959, 40p. incl. illus. diagrs. table, refs. (Rept. no. AD-1118-A-10) (AFOSR-TN-59-1099) (AF 18(603)141) AD 239050; PB 148773
Unclassified

The absorption spectrum of shock-heated molecular oxygen has been measured photoelectrically in the wavelength range 2280 to 2870 Å. Four wavelength bands were used, each about 20 Å wide. The oxygen temperatures ranged from 1500 to 4000°K, and the density from 0.01 to 2.0 atmospheres. The photoelectric results for the 20 Å bands were correlated with previous high-dispersion photographic measurements of transition probabilities and line widths for O_2 . This correlation is shown in graphical form, and the use of this absorption technique to determine a temperature-density parameter for oxygen bearing flows is discussed. (Contractor's abstract)

424

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

STUDIES OF CHEMICAL NONEQUILIBRIUM IN HYPERSONIC NOZZLE FLOWS, by J. G. Hall and A. L. Russo. Feb. 1959 [59]p. incl. diagrs. refs. (Rept. no. AD-1118-A-6) (AFOSR-TN-59-1090) (AF 18(603)141) AD 229131; PB 144945
Unclassified

Published in Conf. on Kinetics, Equilibria, and Performance of High Temperature Systems, Los Angeles, Calif. (Nov. 2-5, 1959), Pacific Palisades, Combustion Inst., 1959, p. 59-13-1 - 59-13-61.

Analyses have been made of chemical nonequilibrium effects in pseudo-one-dimensional nozzle flows where the working fluid is a mixture of a dissociating species and inert diluent. Numerical examples computed on a high-speed digital machine are given for the critical flow of pure oxygen at a reservoir temperature of 5900°K over a wide range of reservoir pressures. A characteristic feature of all solutions is rapid freezing of the oxygen composition downstream of the nozzle throat. Freezing is considerably delayed by increase in reservoir pressure, and to a lesser degree by increase in recombination rate. The temperature dependence of the recombination rate has relatively small influence on freezing. Approximate methods are given for analyzing such flows on the basis of infinite

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reaction-rate solutions. Applications of the approximate methods have been made to nonequilibrium air-flow in hypersonic wind tunnel nozzles and to nonequilibrium hydrogen flow at conditions relevant to space-flight propulsion. From the examples discussed it appears that high reservoir pressures are essential to avoid significant nonequilibrium effects in hypersonic wind tunnel test flows of air and in rocket nozzle flows employing hydrogen-like propellants. For the rocket nozzle, the net effect of nonequilibrium is to make the specific impulse for infinite expansion ratio only weakly dependent on chamber pressure for a given chamber temperature. (Contractor's abstract)

425

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

CHEMICAL NONEQUILIBRIUM EFFECTS IN HYDROGEN ROCKET IMPULSE AT LOW PRESSURES, by J. G. Hall, A. Q. Eschenroeder, and J. J. Klein. Nov. 1959 [10]p. incl. diagrs. (Rept. no. AD-1118-A-8) (AFOSR-TN-59-1192) (AF 18(603)141) AD 229134; PB 146541 Unclassified

Also published in ARS Jour., v. 30: 188-190, Feb. 1960.

Calculations of nonequilibrium hydrogen flows were investigated for a lower range of pressures as well as a wider range of temperatures and nozzle geometry than previously considered. The calculations were made by using an approximate method of analysis (item no. 424) for such flows. The method involves a local relaxation length criterion for determination of the freezing of gas composition; the criterion is evaluated on the basis of corresponding equilibrium flow solutions. A comparison with exact numerical solutions show the criterion to give an accurate prediction of the frozen dissociation level. The approximate method is particularly convenient for determining the limiting specific impulse I_{∞} , attained by expansion to infinite area and zero pressure. Since the specific total enthalpy, h_0 , is constant, I_{∞} is given in terms of h_0 and the final, frozen degree of dissociation

$$I_{\infty} \text{ by, } I_{\infty} = \frac{u_{\infty}}{g} = \frac{1}{g} \left(2(h_0 - \frac{E_D^0}{M}) \right) \text{ where } u_{\infty} \text{ is the}$$

velocity at infinite area, g is the standard gravitational acceleration, E_D^0 is the molar dissociation energy of diatomic species, and M is the diatomic molecular weight.

426

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

DYNAMICAL FEYNMAN'S THEOREM, by E. H. Kerner. [1959] [2]p. (Bound with its AFOSR-TN-59-1086) [AF 18(603)141] Unclassified

Published in Phys. Rev. Lett., v. 2: 152-153, Feb. 15, 1959.

A simple dynamical extension of Feynman's theorem allowing for a calculation of the forces on nuclei in motion is discussed. The conservation of energy and the definition of the nuclei motion is found by use of the formula:

$$MX = - \frac{\partial W}{\partial X} - \int |\psi|^2 \frac{\partial V}{\partial X} dx$$

and a scheme is presented for management of this equation. Essentially what is done in the formulation of this equation is the breaking up of the conservative motion of the whole molecular system into two individual nonconservative parts, of which one part, the nuclear motion, is surveyed in abstraction from the rest.

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

PROPAGATION OF WEAK DISTURBANCES IN A GAS SUBJECT TO RELAXATION EFFECTS, by F. K. Moore and W. E. Gibson. [1959] [8]p. [AF 18(603)141] Unclassified

Published in Inst. Aero. Sci. Awards Papers, p. 57-64, 1959.

A generalized wave equation is derived for sound disturbances in a gas when relaxation efforts are present. Solutions involving discontinuous wave fronts are presented, and under certain assumptions, the complete wave equation reduces to the telegraph equation. Solutions are given for a wavy wall in subsonic and supersonic flow and a simple wedge in supersonic flow. The study is relevant to hypersonic shock waves.

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Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

SPECTROSCOPIC MEASUREMENT OF THE TEMPERATURE OF SHOCK-HEATED OXYGEN, by W. H. Wurster. [1959] [4]p. incl. diagrs. [AFOSR-614] (AF 18(603)141) Unclassified

Published in Proc. Conf. on Phys. Chem. in Aerodynam. and Space Flight, Pennsylvania U., Philadelphia, (Sept. 1-3, 1959), New York, Pergamon Press, 1961, p. 158-161. (AFOSR-TR-60-106)

Also published in Planetary Space Sci., v. 3: 158-161, Feb. 1961.

Preliminary findings are presented of experiments currently in progress in which the ultra-violet absorption of the Schumann-Runge band system of oxygen has been exploited as a means of determining the vibration temperature of heated oxygen. The apparatus is described and results obtained to date are presented. These

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results demonstrate the usefulness of this device in measuring temperatures between 1500° and 3500°K for a limited range of optical thickness. Current work on the measurements to other densities and on the applicability of this technique to the temperature of air is discussed. (Contractor's abstract)

429

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MOLECULAR INTERACTIONS AT HIGH TEMPERATURES, by C. E. Treanor and G. T. Skinner. [1959] [5]p. incl. illus. diagrs. [AF 18(603)141]

Unclassified

Published in Proc. Conf. on Phys. Chem. in Aerodynam. and Space Flight, Pennsylvania U., Philadelphia (Sept. 1-3, 1959), New York, Pergamon Press, 1961, p. 253-256. (AFOSR-TR-60-106)

Also published in Planetary and Space Sci., v. 3: 253-256, Feb. 1961.

An experimental and theoretical program concerning the interaction between gas particles having energies in the 1 to 10 ev range is discussed. A molecular beam has been constructed for the experimental work, using a shock tube as the source of high-energy atoms and molecules. In particular, the interest centers around those interactions characteristic of high-temperature air where considerable dissociation has occurred. The atom-molecule interactions, about which least is known, have been given 1st consideration because of their importance in estimating transport properties. A 2-center potential has been used for preliminary investigation of the diatomic molecule as seen by an approaching atom. (Contractor's abstract)

430

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

THE STUDY OF HIGH TEMPERATURE GASDYNAMIC PHENOMENA BY MEANS OF THE SHOCK TUBE (Abstr.), by A. Hertzberg. [1958] [1]p. [AF 49(638)269]

Unclassified

Presented at Fifty-fifth meeting of the Amer. Acoustical Soc., Washington, D. C., May 7-10, 1958.

The ability of the shock tube to simulate the temperatures and velocities of hypersonic flight has recently spurred its application to the study of high-temperature phenomena in gases. This paper reviewed the application of the shock tube to the study of high-temperature phenomena in gases and discusses some of the more important experiments and investigations that have recently been carried out at Cornell Aeronautical Lab. In particular, the application of the shock tube and its modified forms were discussed in connection with the

study of hypersonic flight, high-temperature chemical kinetics, and high-temperature gas physics. (Contractor's abstract)

431

Cornell Aeronautical Lab., Inc., Buffalo, N. Y.

MEASURED TRANSITION PROBABILITIES FOR THE SCHUMANN-RUNGE SYSTEM OF OXYGEN, by C. E. Treanor and W. H. Wurster. [1959] [34]p. incl. diagrs. refs. (AFOSR-TN-59-946) (AF 49(638)269)

Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 68, Jan. 28, 1959. (Title varies)

Also published in Jour. Chem. Phys., v. 32: 758-766, Mar. 1960.

Transition probabilities for the Schumann-Runge system of O₂ have been measured in absorption in the wavelength region 2650 - 3900A. Oxygen was heated in a shock tube to temperatures up to 4500°K, thereby populating high vibrational and rotational levels. Absorption spectra were photographed using a high-speed flash lamp and a large Littrow quartz spectrograph. Transition probabilities for the bands of 3 sequences, associated with the zero, 1st and 2nd vibrational levels of the excited electronic state, yield an f value of 0.048 ± 0.008 which, when corrected for wavelength dependence, is about 1/3 that determined in the vacuum ultraviolet. This corresponds to a decrease in transition probability with increasing internuclear separation. Line width variations with temperature and density have also been measured. The optical diameter for O₂ - O₂ collisions was determined as 6A and for O₂ - O collisions as 10A. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

ENTROPIES AND ENERGIES OF DIMERIZATION OF ALKALI METAL HALIDES, by S. H. Bauer, R. M. Diner, and R. F. Porter. [1959] [5]p. incl. diagrs. tables, refs. (AFOSR-TN-59-148) (AF 18(603)1) AD 264285

Unclassified

Also published in Jour. Chem. Phys., v. 29: 991-995, Nov. 1958.

Calculated entropies of dimerization for a number of gaseous alkali metal halides, assuming the rhombic planar model for the dimer, fall in the range -31.0 ± 1.5 entropy units. Entropies of dimerization deduced from experimental data for several species diverge appreciably from the calculated values. The differences

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can be attributed to uncertainties in the graphical determination of dimerization energies. Energies of dimerization recalculated by combining experimental values of free energy (dimerization) with theoretical values of entropy (dimerization) correlate well with the interionic separations in the dimers. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MASS SPECTROMETRIC STUDY OF ALKALI HYDROXIDE VAPORS, by R. C. Schoonmaker and R. F. Porter. [1959] [4]p. incl. tables, refs. (AFOSR-TN-59-243) (AF 18(603)1) AD 230886 Unclassified

Also published in Jour. Chem. Phys., v. 31: 830-833, Sept. 1959.

A mass spectrometer has been used to analyze the vapors effusing from the orifice of a Knudsen cell containing pure and mixed alkali hydroxide condensed phases. Monomeric and dimeric species are detected in all cases except for LiOH in the temperature range 650-900°K. Thermochemical data are reported for the reactions $2MOH(g) = M_2(OH)_2(g)$, and $M_2(OH)_2(g) + N_2(OH)_2(g) = 2MN(OH)_2(g)$, where M and N represent constituent alkali metals. The analogous behavior of the vaporization processes of alkali fluorides and hydroxides is discussed. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

A MASS SPECTROMETRIC AND THERMODYNAMIC STUDY OF GASEOUS TRANSITION METAL (II) HALIDES, by R. C. Schoonmaker, A. H. Friedman, and R. F. Porter. [1959] 14p. incl. tables, refs. (AFOSR-TN-59-668) (AF 18(603)1) Unclassified

Also published in Jour. Chem. Phys., v. 31: 1586-1589, Dec. 1959.

Mass spectrometric and Knudsen effusion techniques were used to study the vaporization of several transition metal (II) halides. The systems studied include FeI_2 and the chlorides and bromides of Cr, Mn, Co and Ni. The overall temperature range was between 440 and 700°C. For all systems the monomer is the major species in the temperature range studied. Dimeric species were also detected in the vapor phase for all systems except $NiCl_2$ and $NiBr_2$. Vapor pressure data were combined with mass spectrometric and entropy data to give heats for the dimerization reaction: $2MX_2(g) = M_2X_4(g)$. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MASS SPECTROMETRIC STUDY OF HIGH TEMPERATURE REACTIONS OF $H_2O(g)$ AND $HCl(g)$ WITH Na_2O AND Li_2O , by R. C. Schoonmaker and R. F. Porter. [1959] [21]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1043) (AF 18(603)1) Unclassified

Also published in Jour. Phys. Chem., v. 64: 457-461, Apr. 1960.

The gaseous products formed by reactions of $H_2O(g)$ and $HCl(g)$ with condensed Li_2O and Na_2O phases at high temperatures have been identified mass spectrometrically. At low water pressures the major species produced by reaction of $H_2O(g)$ with $Li_2O(s)$ is $LiOH(g)$. In $Na_2O-H_2O(g)$ experiments, $NaOH(g)$ and $Na_2(OH)_2(g)$ are formed. An estimate of the relative heats of dimerization of $LiOH$ and $NaOH$ was obtained from the results of experiments with the $Na_2O-Li_2O-H_2O(g)$ system. In the systems $Na_2O-NaCl-H_2O(g)$ and $Na_2O-HCl(g)$ the mixed anion dimer, $Na_2(OH)Cl(g)$, is formed in addition to $Na_2(OH)_2(g)$ and $Na_2Cl_2(g)$. Because of ambiguities due to the ion fragmentation patterns of $Na_2(OH)_2$, Na_2Cl_2 , and $Na_2(OH)Cl$ the existence of the latter species is necessarily inferred from the dependence of ion current intensities on flow rate of the reactant gas. Similar behavior was noted for the system $Na_2O-NaF-H_2O(g)$.

Comparison of ion fragmentation patterns obtained in studies with pure $LiCl$ and with the $Li_2O-HCl(g)$ system indicates that Li^+ ions are formed from both $LiCl(g)$ and $Li_2Cl_2(g)$ molecules at high electron energies. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

STABILITIES OF THE GASEOUS MOLECULES $BiSe$, $BiTe$, AND $SbTe$, by R. F. Porter. [1959] [5]p. incl. table. (AFOSR-TN-59-1226) (AF 18(603)1 and AF 49-638)480 Unclassified

Also published in Jour. Chem. Phys., v. 32: 943-944, Mar. 1960.

An investigation was made to gather thermochemical data from which dissociation energies of the molecules studied could be obtained. The experiment utilized a mass spectrometric identification of the vapor species escaping from an effusion cell in which condensed-vapor equilibrium was maintained. In the $Bi-Se$ and $Bi-Te$ systems ion currents of Bi^+ , Bi_2^+ , BiX^+ , X_2^+ were

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observed. These formations were thought to be due to processes of simple ionization by electron impact. Experimental values for K' for several systems were calculated and presented in table form along with ΔH and ΔS values. The Sb-Se and Sb-Te systems were found to be very complicated in their vaporization due to polyatomic species in high concentration.

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

MEAN-FIRST-PASSAGE TIMES AND THE COLLISION THEORY OF BIMOLECULAR REACTIONS, by B. Widom. [1959] [8]p. (AFOSR-TN-59-51) (AF 18(603)-111) AD 231831 Unclassified

Presented at Symposium on Absolute Reaction Rates, Madison, Wis., Mar. 1959.

Also published in Jour. Chem. Phys., v. 31: 1387-1394, Nov. 1959.

A general collision theory is outlined for the kinetics of reaction of molecules which are dilutely dispersed in an inert gas, the reaction being the result of binary collisions between the reacting molecules and the inert gas molecules. It is assumed that the products of reaction are instantaneously removed from the system. The mean-first-passage time for the transition from reactant to product states is expressed in terms of the solution of an integral equation in which the kernel is the transition probability per unit time between 2-states of the reacting molecule. When a rate constant exists, it is the reciprocal of the mean-first-passage time. In a 1-dimensional system, or in a system of 2 or 3 dimensions where the interaction between colliding molecules has a finite range, there exists a finite collision number Z which is independent of the internal state of the reacting molecule. In such a case there is a Liouville-Neumann solution of the integral equation which allows the mean-first-passage time to be expressed as a sum of contributions corresponding to failure to react after no collisions, after 1 collision, after 2 collisions, etc. The equilibrium hypothesis is analyzed, and it is seen what the precise nature of that approximation is. (Contractor's abstract, modified)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

COLLISION THEORY OF THE KINETICS OF DISSOCIATION OF DIATOMIC MOLECULES, by B. Widom. [1959] [3]p. (AFOSR-TN-59-250) (AF 18(603)111) AD 229673 Unclassified

Also published in Jour. Chem. Phys., v. 31: 1027-1029, Oct. 1959.

A collision theory is developed for the rate of dissoci-

ation of diatomic molecules dilutely dispersed in an inert gas, the theory being identical in its basic structure to the collision theory of Rice but differing from the latter in some of its details. The rate constant is found to be

$$K = C(\mu^{\frac{1}{2}} A^{\frac{1}{2}} / h r_0^2) Z \exp(-D/kT),$$

where Z is the collision number, D the dissociation energy, μ the reduced mass of the diatomic molecule, r_0 its equilibrium internuclear distance, A the magnitude of the coefficient of the attractive r^{-6} term in the long-range interaction energy of its 2 atoms of its diatomic molecule, and C a dimensionless constant estimated to be 0.27. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

ROTATIONAL RELAXATION OF ROUGH SPHERES, by B. Widom. [1959] [11]p. incl. tables. (AFOSR-TN-59-984) (AF 18(603)111) AD 236291 Unclassified

Also published in Jour. Chem. Phys., v. 32: 913-923, Mar. 1960.

A theory of rotational relaxation of spherical top molecules in an inert gas is given, under the assumption that the molecules and the atoms collide as rough spheres. Some general aspects of relaxation theory are first discussed and a theorem is presented which, under some circumstances, allows the problem to be greatly simplified. The rotation relaxation problem is then solved both for two- and three-dimensional systems. If I is the moment of inertia of the rotating molecule, M the reduced mass of the atom-molecule system, and α the sum of the atomic and molecular radii, and if $b = I/M\alpha^2$, then the most important result of the three-dimensional theory is that $Z_{\text{eff}} = 3/8(1 + b)^2/b$, where Z_{eff} is the number of collisions suffered by each molecule in a time equal to the relaxation time. This is the analog of a result previously derived by Wang Chang and Uhlenbeck for self-relaxation in the pure molecular gas. Values of Z_{eff} are calculated for a variety of mixtures of spherical top molecules with inert gases. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

THALLIUM TUNGSTEN BRONZE: A NEW DEFECT STRUCTURE, by M. J. Sienko. July 1, 1959 [21]p. incl. diagrs. (AFOSR-TN-59-504) (AF 49(638)191) AD 215929; PB 143000 Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

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Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 3-M.

Also published in Jour. Amer. Chem. Soc., v. 81: 5556-5559, Nov. 5, 1959.

Thallium tungsten bronzes, Tl_xWO_3 , were prepared ranging in composition from $x = 0.19$ to $x = 0.36$. Preparation methods included: (1) heating Tl_2WO_4 , WO_3 , and W; (2) vapor phase reaction of Tl and WO_3 ; (3) electrolysis of Tl_2CO_3 and WO_3 mixtures. Products were crystallized and powder diagrams could be indexed in the hexagonal system with $a = 14.53\text{\AA}$ and $c = 7.27\text{\AA}$. Electrical resistance measurements using a potential probe method on single crystals indicated metallic conduction with specific resistivity varying from $6.0 \times 10^{-3} \text{ ohm-cm}$ at 25°C to $9.0 \times 10^{-3} \text{ ohm-cm}$ at 240° . Thermoelectric power at room temperature was -70 microvolts per degree referred to platinum, suggesting 1 free electron per thallium atom. A general model is proposed for the tungsten bronzes M_xWO_3 where M is viewed as an interstitial atom giving rise to local energy levels in the forbidden gap between the conduction and valence bands of WO_3 . (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

THE TEMPERATURE DEPENDENCE OF RAMAN INTENSITIES, by G. W. Chantry. [1959] 7p. incl. table. (AFOSR-TN-59-743) (AF 49(638)279) AD 227604; PB 143997 Unclassified

Also published in Jour. Chem. Phys., v. 32: 222-223, Jan. 1960.

The temperature dependence of the intensity of the Raman lines of a polyatomic molecule was investigated. It is shown that, when account is taken of all possible "hot" band transitions as well as fundamental transitions, the temperature dependence of each band is the same as that found for the single band of a diatomic molecule. Degenerate vibrations are also considered and likewise shown to have the same temperature dependence. (Contractor's abstract)

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Cornell U. Dept. of Chemistry, Ithaca, N. Y.

RAMAN INTENSITIES OF THE A_1 LINES OF OXYANIONS, by G. W. Chantry and R. A. Plane. Aug. 11, 1959, 10p. incl. tables, refs. (AFOSR-TN-59-807) (AF 49(638)279) AD 227607; PB 144013 Unclassified

Also published in Jour. Chem. Phys., v. 32: 319-321, Feb. 1960.

The trace of the derived polarizability tensor has been measured on an absolute scale for the ions CO_3^{-2} , NO_3^- , PO_4^{-3} , SO_4^{-2} and ClO_4^- in aqueous solution.

From these and the known normal coordinate matrix elements, the values of the derivative with respect to bond length have been calculated. Results are interpreted in terms of bond order and indicate appreciable π bonding in the ions NO_3^- , SO_4^{-2} and ClO_4^- . In these cases, as opposed to hydrocarbons, a π electron makes a larger contribution to the derived bond polarizability than does a σ electron. (Contractor's abstract)

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

MARKOFF PROCESSES AND POTENTIALS I, by G. A. Hunt. [1957] [50]p. incl. refs. [AF 18(600)685] Unclassified

Published in Illinois Jour. Math., v. 1: 44-93, Mar. 1957.

This article establishes close connections between the general potential theory and the homogeneous Markov processes. A precise and general treatment of the relations between the Newtonian theory and the Brownian movement is given. Regularity hypothesis are assumed with the following properties: if the P_t are the probabilities of the path of a homogeneous Markov process, the "kernel" $U = \int_0^\infty P_t dt$ satisfies the fundamental principles of the potential theory, such as the maximum principles. A semi-group of probabilities corresponds inversely to a kernel satisfying these principles. X is taken to be a locally compact separable space. The entire family $\{K_r\}_{r \in X}$ of positive Radon measures on X is studied, such that the charge $K(r, A)$ of K_r on the Borelean $A \subset X$ can be a measurable function of r for all Radon measures.

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

MARKOFF PROCESSES AND POTENTIALS II, by G. A. Hunt. [1957] [54]p. [AF 18(600)685] Unclassified

Published in Illinois Jour. Math., v. 1: 316-369, Sept. 1957.

This report shows the relative general potential theory to be, in a sense, complete. Terminal time S is replaced by one defined in terms of a function a and a set A . Excessive functions, defined as a positive function ϕ if it is measurable over the field A and if $K\tau\phi$ increases to ϕ as τ decreases to 0 are discussed. Various theorems on associated functions and measures

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are developed. The creation of mass is discussed from the standpoint that it can be postulated on the basis of the hypothesis that the paths behave well for all time.

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Cornell U. Dept. of Mathematics, Ithaca, N. Y.

CONVERGENCE OF ORTHOGONAL SERIES, by R. P. Agnew. Mar. 1959, 8p. (Rept. no. 81) (AFOSR-TN-59-206) (AF 18(600)685) AD 211360; PB 140025
Unclassified

Also published in Duke Math. Jour., v. 27: 127-131, 1960.

The following theorem is proved: if a_0, a_1, a_2, \dots is a sequence of real or complex constants for which

$$\sum |a_k|^2 = \infty, \text{ and if } I \text{ is a real 1-dimensional interval,}$$

then there is a set ϕ_0, ϕ_1, \dots which is orthonormal

over I and is such that $0 = a_0\phi_0(x) + a_1\phi_1(x) + a_2\phi_2(x) + \dots$ for each x in I .

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

THE EQUIVALENCE OF TWO EXTREMUM PROBLEMS, by J. Kiefer and J. Wolfowitz. [1959] [4]p. (AFOSR-TN-59-255) (AF 18(600)685) AD 244073
Unclassified

Also published in Canad. Jour. Math., v. 12: 363-366, 1960.

Let f_1, \dots, f_k be continuous, real, linearly independent functions on a compact space X . Consider any convex set of probability measures ξ on a Borel field of subsets of X , which includes the measures with finite support, and for which $m_{ij}(\xi) = \int f_i(x)f_j(x)\xi(dx)$ is defined. Let $M(\xi) = \|m_{ij}(\xi)\|$, and $[M(\xi)]^{-1} = \|m^{ij}(\xi)\|$ if $M(\xi)$ is nonsingular. Write $f(x)$ ($f(x')$) for the column (row) vector with components $f_i(x)$. It is shown that the following 3 criteria are equivalent: (1) ξ^* maximizes $\det M(\xi)$; (2) ξ^* minimizes $\max_x f(x)'[M(\xi)]^{-1}f(x)$; (3) $\max_x f(x)'[M(\xi^*)]^{-1}f(x) = k$. A corollary is that there always exists a measure ξ such that, for suitable constants a_{ij} , the functions $g_i = \sum_j a_{ij}f_j$ are orthonormal with respect to ξ and $\max_x \sum_i g_i^2(x) = k$. Analogous results hold if one assumes only that the f_i are bounded and linearly independent. The results have applications to the determination of optimum statistical designs.

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

ASYMPTOTIC EXPANSIONS IN GLOBAL CENTRAL LIMIT THEOREMS, by R. P. Agnew. [1959] [17]p. (AF 18(600)685) Unclassified

Published in Ann. Math. Stat., v. 30: 721-737, Sept. 1959.

Consider the distribution function (d.f.) $F_n(x)$ of the normalized sum $(\xi_1 + \xi_2 + \dots + \xi_n)^{1/2}$ where the ξ 's are independent random variables with the same d.f., $F(x)$, having zero mean and unit variance. This paper studies the asymptotic behavior of constants $C_n(p) = \int_{-\infty}^{\infty} |F_n(x) - \Phi(x)|^p dx$, $\Phi(x)$ being the Gaussian d.f. Primary interest

is focused on the case $p = 2$, for which conditions are presented under which there exists constants D_1 such that

$$C_n(2) = C_n = \sum_{i=1}^k D_i n^{-1} + O(n^{-k-1}).$$

Different approaches are required depending on whether or not the magnitude of the characteristic function (c.f.) of $F(x)$ is periodic. It is shown that $D_1 = A_1 = B_1$, where B_1 is needed only

when the c.f. is periodic. Methods extending the results to $k > 2$ are indicated. Specific results are presented for a uniform d.f. (non-periodic and a binomial d.f. (periodic). Extensive computations are made for the symmetric binomial d.f., with results for $k \leq 5$. Values of C_n

are presented for $n \leq 10$ and a very good approximation is available for $n \geq 5$. (Math. Rev. abstract)

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Cornell U. [Dept. of Mathematics] Ithaca, N. Y.

ON THE GROWTH OF MEROMORPHIC FUNCTIONS WITH SEVERAL DEFICIENT VALUES, by A. Edrei and W. H. J. Fuchs. [1959] [37]p. incl. refs. [AF 18(600)-685] Unclassified

Published in Trans. Amer. Math. Soc., v. 93: 292-328, Nov. 1959.

The possibility of proving analogous theorems for meromorphic functions possessing deficient values was investigated. The results obtained give a partial answer to the question of under which conditions are deficiencies invariant under a change of origin. It is shown that under the conditions of letting $f(x)$ be an entire function of finite order λ and letting $M(r)$ denote its maximum modulus in the region $|z| \leq r$, assertion (i) of the following theorem cannot hold for all meromorphic functions satisfying the inequality $K(f) < 1$. If some value τ ($\neq \infty$) is exceptional in the sense of Borel, then (i) λ is a positive integer; (ii) $\log M(r) \sim \alpha r \lambda$ for positive value of α . However, the following theorem shows that some connection exists between the order λ , of $f(x)$ and the numerical value of $K(f)$. Let $k(\lambda) = \inf (K(f))$ where

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f ranges over all meromorphic functions of order λ . Then $k(\lambda) = 0$, ($\lambda = 1, 2, 3, \dots$). For all other λ , $k(\lambda) > 0$. Proof of the following theorem is presented. Let $f(x)$ be a meromorphic function of finite order λ . Then $K(r) \geq \frac{|\sin \pi \lambda|}{2.2\lambda + 1/2 + |\sin \pi \lambda|}$ which gives the correct order of magnitude of $k(\lambda)$.

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[Cornell U. Dept. of Mathematics, Ithaca, N. Y.]

[DEFICIENT AND ASYMPTOTIC VALUES OF MEROMORPHIC FUNCTIONS] Valeurs déficientes et valeurs asymptotiques des fonctions méromorphes, by A. Edrei and W. H. J. Fuchs. [1959] [38]p. (AF 18(600)685) Unclassified

Published in Comment. Math. Helvetici, v. 33: 258-295, 1959.

The following questions are raised by the theorem of meromorphic functions. (1) If an entire function $f(z)$, of infinite order, admits an exceptional value, its order is of necessity whole, positive, and perfectly regular. Is this valid if it is assumed that $f(z)$ is meromorphic and the sum of the deficiencies exceeds unity? (2) It is known that meromorphic functions exist, even for entire functions of finite order, for those values which are deficient without being asymptotic. When are deficient values also asymptotic values, or does this signify that the above must be completely denounced in order to establish a liaison between the 2 exceptional values? (3) How does the presence of deficient values influence the gap of the Taylor expansion of an entire function? In this report particular attention is directed at the latter 2 questions. The methods of giving a good approx of $\log |f(z)|$ in the function $T(|z|, f)$ are shown. This leads to showing that if the order of the entire function $f(z)$ is finite, and the sum of the deficiencies is sufficiently great, there exist deficient values which are also asymptotic.

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Cornell U. Dept. of Mathematics, Ithaca, N. Y.

CONVERGENCE OF THE EMPIRIC DISTRIBUTION FUNCTION ON HALF SPACES, by J. Wolfowitz. [1959] [4]p. (AFOSR-TN-59-454) [AF 49(638)226] AD 214943 Unclassified

Also published in Contributions to Probability and Statistics, Stanford, Stanford U. Press, 1960, p. 504-507.

Let $(X_1, Y_1), (X_2, Y_2), \dots$, be a sequence of independent chance variables with the same distribution function (d.f.) as (X, Y) . Let p be a real parameter, $F(x|p)$ be the d.f. of $pX + Y$, and $F_n(x|p)$ be the empiric d.f. of $(pX_1 + Y_1), \dots, (pX_n + Y_n)$. The author proves under no restric-

tions on the d.f. of (X, Y) , that $P\left\{\lim_{n \rightarrow \infty} \sup_{-\infty < p < \infty} \sup_{-\infty < x < \infty} |F_n(x|p) - F(x|p)| = 0\right\} = 1$. This result was proved by Fortet and Mourier (Ann. Ecole Normale Super, v. 60, (1953) under the assumption that the d.f. of (X, Y) is absolutely continuous, and by the author (Arn. Math. Stat., v. 25, 1954) under the assumption that X and Y are independent. It is possible to extend this result to more complex regions than half-spaces, and to sequences which are not independent. (Contractor's abstract)

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Cornell U. Dept. of Mathematics, Ithaca, N. Y.

LOTOTSKY AND HAUSDORFF METHODS FOR EVALUATION OF SERIES (Abstract), by R. P. Agnew. [1959] [1]p. (AFOSR-TN-59-792) [AF 49(638)226] Unclassified

A continuation is presented of the development of properties of the new and powerful Lototsky method L for evaluation of series (COR.05:043, Vol. I). The principal new result is the fact that L is consistent with each regular Hausdorff method H . Relations are given involving L and other new methods introduced by Vuckovic in Yugoslavia in 1958 and by Herlestam in Sweden in 1959. (Contractor's abstract)

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Cornell U. [Dept. of Physics] Ithaca, N. Y.

USE OF SYNCHROTRON ORBIT-RADIATION IN X-RAY PHYSICS, by L. G. Parratt. [1959] [3]p. incl. diagr. table. (AFOSR-4021) [AF 18(600)300] Unclassified

Also published in Rev. Scient. Instr., v. 30: 297-299, Apr. 1959.

This report makes a comparison of the prospective usefulness of the intense x-radiation emitted by the centripetally accelerated electrons in the orbit of a high-energy synchrotron in the range of wavelengths 0.1 to 20A. The results, presented in table form, indicate that at wavelengths in the range of 1A, the synchrotron shows no advantage over the conventional tube. However, with a 1-bev beam at wavelengths of 10A, the synchrotron beam demonstrates a great advantage over the conventional tube. It is also shown that with a beam of 6-bev, the synchrotron beam is better, even at a distance on 1A. It is concluded that the great advantage of the synchrotron beam is in emission spectroscopy (1) for those materials that cannot be fabricated easily into x-ray tube targets or that, as targets, cannot dissipate many watts of power, (2) in minimizing contamination, physical or chemical changes, etc., of the emitting material, (3) in controlling and knowing the temperature of the emitting material, and (4) in reducing the relative intensity of the ubiquitous bremsstrahlung background radiation.

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Cornell U. Dept. of Physics, Ithaca, N. Y.

STUDIES OF THE MORPHOLOGY AND STRUCTURE OF COPPER FILMS DEPOSITED BY VACUUM EVAPORATION, by B. M. Siegel. Dec. 15, 1958 [61]p. incl. illus. diags. refs. (Technical rept. no. 9) (AFOSR-TN-59-7) (AF 18(600)674, Task I) AD 203303; PB 139654

Unclassified

A study was made on thin copper films deposited by vacuum evaporation on mica at temperatures from room temperatures to above 400°C. These films, ranging in thickness from 50 to 1000 Å were examined by transmission and replica electron microscopy, and by electron diffraction. The investigation characterized the crystallite size and orientation. It was also possible to demonstrate stacking faults in individual crystallites. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

A STUDY OF REFLECTED XENON IONS FROM PLATINUM, by D. S. Beers. Mar. 1, 1959 [63]p. incl. diags. tables, refs. (Technical rept. no. 10) (AFOSR-TN-59-151) (AF 18(600)674, Task I) AD 210985; PB 140620

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 221, Apr. 30, 1959. (Title varies)

A study was undertaken to determine the characteristics of Xe ions reflected from a Pt surface to improve understanding of the nature of reflected ions. The apparatus and procedure used were previously described (COR.08:017, Vol. II). Results indicated that (1) the measured yield of reflected ions is independent of the incident-ion current and the energy of the incident-ions, (2) the energy of the reflected ions is approximately 0, (3) the variation of the yield of reflected ions with ambient Xe pressure and target temperature approximately satisfies an empirical equation, and (4) the estimated true yield of reflected ions is of the order of 10^{-4} (infinite Xe pressure). The experimental results are in agreement with previous studies of reflected inert-gas ions, but are in disagreement with previous studies of reflected alkali ions. Several tentative mechanisms are discussed to account for the ionization and ejection of the adsorbed Xe atoms.

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Cornell U. Dept. of Physics, Ithaca, N. Y.

STUDIES ON THE NUCLEATION, GROWTH AND OXI-

DATION OF EVAPORATED COPPER FILMS WITH A HIGH VACUUM ELECTRON DIFFRACTION CAMERA, by B. M. Siegel and C. C. Peterson. [1959] [11]p. incl. illus. diags. tables, refs. (Technical rept. no. 14) (AFOSR-TN-59-1195) (Also bound with its AFOSR-TR-59-212) (AF 18(600)674, Task I) Unclassified

Also published in Proc. Internat'l. Conf. on Structure and Properties of Thin Films, Bolton Landing, N. Y. (Sept. 9-11, 1959) New York, John Wiley and Sons, p. 97-107.

A study is made of the behavior of very thin deposits of copper (less than 30 Å average thickness) under varied conditions of heat treatment and oxidation with an ultra-high vacuum electron diffraction camera that studies the crystallographic structure of the deposited films and follows the reactions on the surface of the "clean" films. The 3 phase study included: (1) The changes of very "thin" copper deposits under heat treatment. (2) The character of the oxidation of these copper deposits and the heat treatment of the oxide. (3) The reduction of the oxide. The most surprising observation is that the copper deposit disappears upon heat treatment at 350°C. Possible explanations of this are presented. An electron micrograph of a copper deposit after heat treatment and partial oxidation is explained pointing out the copper particles and the cuprous oxide.

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Cornell U. Dept. of Physics, Ithaca, N. Y.

A STUDY OF A PLATINUM SURFACE USING A MASS SPECTROMETER, by R. C. Bradley and A. Arking. May 1, 1959 [56]p. incl. diags. tables, refs. (Technical rept. no. 11) (AFOSR-TN-59-271) (AF 18(600)674, Task II) AD 212705; PB 144215

Unclassified

The mass spectrometric analysis of particles ejected from a metal surface by the impact of inert gas ions provides information on sputtering, on surface and bulk compositions, and on surface and bulk kinetics. The present paper describes some experiments on platinum, using this technique. In particular the formation of PtO_3 on the Pt surface and its subsequent removal, either by evaporation or by ion bombardment was described. This is presented in detail in Section IV. Section II describes the experimental arrangements and techniques, and Section III pertains to sputtered particles other than PtO_3 .

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Cornell U. Dept. of Physics, Ithaca, N. Y.

INVESTIGATION OF AN ALLOY SURFACE WITH THE FIELD EMISSION MICROSCOPE, by R. C. Bradley and L. A. D'Asaro. [1959] [8]p. incl. illus.

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diags. tables, refs. (Technical rept. no. 12)
(AFOSR-TN-59-480) (AF 18(600)674, Task II)
AD 215733 Unclassified

The field emission microscope has been used to investigate the surface of an alloy of a few % zirconium in molybdenum. The field emission patterns indicate that a high-temperature flash (2000°K) reduces the surface concentration of zirconium to zero. Subsequent heat treatment at 1000°K brings Zr to the emitting surface where it adsorbs preferentially in small clusters on the lattice steps of the (100) planes. These clusters are easily observed because of their high electron emission. Their emission characteristics reveal them to be smooth layers of low work function (2.64 ± 0.01 eV) rather than protruding crystallites. When the bulk concentration of zirconium in the alloy is increased from 1% to 5%, the emission patterns change markedly, but there is little effect on the adsorption characteristics of the surface. Surface migration, desorption, and bulk diffusion of zirconium were found to proceed rapidly at temperatures above 1200°K, 1500°K, and 2000°K, respectively. Measurements of activation energies for surface migration and desorption gave 2.7 ± 0.3 eV and 4.15 ± 0.15 eV, respectively. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

DIFFUSION AND DESORPTION OF METAL IMPURITIES IN PLATINUM, by R. C. Bradley. Oct. 1, 1959 [17]p. incl. diags. tables, refs. (Technical rept. no. 13) (AFOSR-TN-59-1004) (AF 18(600)674, Task II) AD 233154; PB 145868 Unclassified

Also published in Phys. Rev., v. 117: 1204-1207, Mar. 1, 1960.

Activation energies for the volume diffusion of certain impurities in polycrystalline platinum samples have been obtained by studying the ions released from their surfaces at temperatures above 1000°C. For one Pt sample these energies were 4.7 ± 0.2 eV for K, and 3.7 ± 0.2 eV for Ca. For a second sample, however, all the energies were 10 - 15% higher. After periods of inert gas ion bombardment at room temperature, burst of K^+ and Na^+ ions were released at temperatures of about 600°C and 700°C, respectively. Activation energies associated with this release were 1.9 ± 0.1 eV for K^+ and 2.6 ± 0.1 eV for Na^+ . In this case there was close agreement between the two different samples. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

PRECISE WAVELENGTH OF A WIDE SPECTRAL LINE AND PRECISE LATTICE PARAMETER OF A CRYSTAL,

by J. O. Porteus and L. G. Parratt. May 1, 1959, 17p. incl. diags. refs. (Technical rept. no. 3) (AFOSR-TN-59-305) (AF 49(638)402) AD 213089; PB 142063

Unclassified

In precision determinations of crystal lattice parameters, crystallographers recently pointed out that certain advantages accrue if the centroid of the diffraction pattern and of the x-ray line are used as reference angle (or wavelength) positions. Certain disadvantages are also pointed out: (1) the lattice parameter so determined refers necessarily to the centroid of the crystal pattern, (2) in order to keep the Bragg law simple and to avoid double-valued lattice parameters, the centroid proposal implies that x-ray wavelengths in general should refer to the centroid of the respective lines, and (3) there is an inherent experimental imprecision in the determination of the centroid of any line or pattern having long tails that fade gradually into the ubiquitous background. The 3rd point is argued qualitatively in terms of the general signal-to-noise ratio. This inherent imprecision is largely avoided if the peak position of the line is used as the reference position (defined as the intersection of the line profile with the curve drawn through the bisecting points of the horizontal chords of the line) and if the parameter position of the crystal pattern is taken as the bisector of the chord. These reference positions also avoid the Bragg law complication. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

PROBABILITY FOR AN INNER TWO-ELECTRON TRANSITION: X-RAY $K\beta'$ SATELLITE, by M. Sawada, T. Watanabe, and L. G. Parratt. May 14, 1959, 15p. incl. diag. tables. (Technical rept. no. 4) (AFOSR-TN-59-459) (AF 49(638)402) AD 215264; PB 142156

Unclassified

An explanation was recently proposed by Parratt for the rather intense radiation observed on the low-energy side of each of many x-ray emission lines. This explanation, in terms of excitation states, is based on a fundamental departure from the conventional type of x-ray energy level diagram. In some important cases the emission in question, e.g., the so-called $K\beta'$ lines of the elements of the first transition group, had previously been interpreted by Sawada as a 2-electron transition type of x-ray satellite. This interpretation was based on wavelength positions, and in regard to intensity it was purely qualitative. Because of the fundamental nature of the excitation state proposal, the theoretical relative intensity of the 2-electron-jump type of satellite is explored in the present paper; it is found to be too low. Accordingly, this model for at least the bulk of the $K\beta'$ line is untenable.

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Cornell U. Dept. of Physics, Ithaca, N. Y.

LINE ASYMMETRY AND SATELLITES IN X-RAY SPECTRA: EXCITATION STATES, by M. H. Skolnick and L. G. Parratt. May 20, 1959, 38p. incl. diagrs. table, refs. (Technical rept. no. 5) (AFOSR-TN-59-505) (AF 49(638)402) AD 215939; PB 142181

Unclassified

Calculations are presented for the K spectra of solid metallic manganese. This many-electron model is able to explain satisfactorily the observed asymmetries of the $K\alpha_{1,2}$ lines and the origin of the $K\beta'$ satellite lines for elements in the first transition group. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

AN OPTIMIZED METHOD FOR CORRECTING FOR SMEARING ABERRATIONS: COMPLEX X-RAY SPECTRA, by J. C. Porteus and L. G. Parratt. Sept. 1, 1959, 1v. incl. diagrs. tables, refs. (Technical rept. no. 7) (AFOSR-TN-59-754) (AF 49(638)402) AD 226880, PB 143952

Unclassified

Also published in Jour. Appl. Phys., v. 33: 700-707, Feb. 1962.

The true spectrum $T(\nu)$ is desired from the observed spectrum $O(\nu_n)$ which has been recorded with a spectrometer whose smearing or "spectral window" function is $M(\nu_n - \nu)$, i.e., we seek to correct $O(\nu_n)$ for the smearing effect of $M(\nu_n - \nu)$. The correction involves the convolution or folding integral

$$O(\nu_n) = \int_{-\infty}^{\infty} T(\nu) M(\nu_n - \nu) d\nu.$$

This problem, with appropriate terminology, arises in almost every facet of experimental science. A mathematically unique solution exists only in case $O(\nu_n)$ and $M(\nu_n - \nu)$ are exactly known for all ν . Many investigators have attacked this problem and many different "practical solutions" have been proposed. The problem is re-examined from the point of view of correcting x-ray spectra for resolving power, and previous solutions are found to be inadequate. A new optimized solution is proposed. The errors in this solution are discussed in detail. The specific spectral examples to which the new method is applied are the K emission and absorption of crystalline potassium chloride. (Contractor's abstract)

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Cornell U. Dept. of Physics, Ithaca, N. Y.

X-RAY REFLECTION STUDIES OF THE ANNEAL AND OXIDATION OF SOME THIN SOLID FILMS, by N. Wainfan and L. G. Parratt. Aug. 25, 1959 [20]p. incl. diagrs. refs. (Technical rept. no. 6) (AFOSR-TN-59-755) (AF 49(638)402) AD 226979; PB 143951

Unclassified

Also published in Jour. Appl. Phys., v. 31: 1331-1337, Aug. 1960.

The technique of the total reflection of x-rays has been applied to the study of thin vacuum-deposited films of Cu, Ni, Ge, and Se on polished glass substrates. Starting with fresh films "smooth" enough to exhibit pronounced x-ray interference fringes in the region just beyond the critical angle, the effects of vacuum anneal and oxidation were studied. Changes in the reflection curves are interpreted in terms of possible structural changes in the films. These reflectivity changes are examined in the light of results obtained from the study of x-ray reflection from layers of particles of carbon or polystyrene latex deposited onto "smooth" substrates. (Contractor's abstract)

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Cornell U. [Dept. of Physics] Ithaca, N. Y.

THE STRUCTURE OF VACUUM-DEPOSITED FILMS AS DETERMINED FROM THE TOTAL REFLECTION OF X-RAYS (Abstract), by N. Wainfan, R. Sviedrys and others. [1959] [1]p. [AF 49(638)402]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 265, Apr. 30, 1959.

A vacuum x-ray reflectometer has been constructed to allow measurement of the coefficient of reflection of optically flat surfaces at small glancing angles while the mirror is contained in a temperature-controlled vacuum chamber. This instrument has been applied to the study of metal films vacuum-deposited onto optically flat glass and Pyrex substrates. The x-ray wavelength used in this work is 1.54A. A measurement of the x-ray reflection coefficient as a function of glancing angle yields information about the density, the density distribution and thickness of the metal film. The new instrument extends previous investigations to the study of the oxidation-reduction and annealing processes. Data will be presented illustrating the effects of the oxidation, reduction, and anneal on copper films in the thickness range between 400 and 1200A. X-ray reflection curves will be interpreted in terms of possible film structures.

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Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

THE RESPONSE OF LAMINAR BOUNDARY LAYER
TO IMPULSIVE MOTIONS, by M. L. Rosenzweig.
Feb. 1959, 96p. incl. diagrs. tables, refs. (AFOSR-
TN-59-92) (AF 18(600)1523) AD 210182; PB 146843
Unclassified

An investigation was conducted on the response of the laminar boundary layer in 2-dimensional, incompressible flow to impulsive changes in velocity. In particular, the problem of stagnation-point flow against a wall which moves impulsively in its own plane is considered. A method is developed for the solution of this problem. Applications of this method are then made to the case of linearized, unsteady, laminar boundary-layer flow. Detailed calculations are carried out to determine the oscillatory response of the laminar boundary layer when the basic steady flow is that given by the potential velocity distribution. The results of these calculations are then used to find the response to impulsive changes of velocity. (Contractor's abstract)

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Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

ON THE MOTION OF THIN AIRFOILS IN FLUIDS OF
LARGE BUT FINITE ELECTRICAL CONDUCTIVITY, by
J. E. McCune. [1959] [39]p. incl. diagrs. (AFOSR-
TN-59-456) (AF 18(600)1523) AD 215030
Unclassified

A 2-dimensional, small-perturbation theory for the steady motion of thin lifting airfoils in an incompressible conducting fluid, with the uniform applied magnetic field perpendicular to (and in the plane of) the undisturbed, uniform flow field, is described. The conductivity of the fluid is assumed to be such that the magnetic Reynolds number (R_m) of the flow is large

but finite. Within this assumption, a theory based on superposition of sinusoidal modes is constructed and applied to some simple thin airfoil problems. It is shown that with this particular field geometry the Alfvén wave mechanism is important in making possible very deep penetration into the flow field of currents and their associated vorticity. It is also shown that the current penetration for an airfoil is much larger than for a wavy wall of wave length equal to the airfoil chord. A value of $R_m = 5$ is found to be a good approximation to infinity; use of the present technique for values of R_m on the order of unity is permissible.

These results provide an indication of what is meant by large magnetic Reynolds number in 2-dimensional magneto-aerodynamics. (Contractor's abstract)

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Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

FLUTTER ANALYSIS OF A SUPERSONIC RING WING,
by P. Crimi. June 1959, 32p. incl. diagrs. table, refs.
(AFOSR-TN-59-685) (AF 18(600)1523) AD 227075
Unclassified

Also published in Jour. Aero/Space Sci., v. 29: 578-
582, May 1962.

The possibility of flutter of a supersonic ring wing is investigated by using linearized equations. The elastic system is limited to flexural deformations and piston theory is employed for aerodynamic pressures. By means of Lagrange's equations, the equations of motion are derived, and expressions for critical Mach number and flutter frequency obtained. Results are restricted to wings of moderately high aspect ratio by the simplified aerodynamics. A representative airfoil cross-section is chosen and flutter quantities calculated for various values of geometric parameters and mode number. Both analytical and numerical results seem to indicate that the system investigated is highly stable. (Contractor's abstract)

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[Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.]

THEORY OF THE MAGNETIC BOUNDARY LAYER,
by V. N. Zigulev, tr. by W. J. Rae. [1959] 5p. incl.
diagrs. (AFOSR-TN-59-872) (AF 18(600)1523)
AD 236059
Unclassified

Trans. from Dokl. Akad. Nauk SSSR, v. 124: 1001-1004,
1959.

Examples are cited which illustrate the phenomenon that a moving plasma is shielded from an external magnetic field and from the electric currents that flow in it. The thickness of the shielding layer, called a magnetic boundary layer, has the order $1/\sqrt{Re_m}$ for motions at large magnetic Reynolds numbers.

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Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.

ON THE TURBULENT BOUNDARY LAYER WITH
FLUID INJECTION, by D. L. Turcotte. July 1959 [7]p.
incl. diagr. (AFOSR-TN-59-874) (AF 18(600)1523)
AD 236963; PB 147634
Unclassified

By introducing a sublayer region in which the intensity of turbulence grows at a prescribed rate, the reduction in wall shear stress due to fluid injection is found for

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a turbulent boundary layer. With the decrease in wall shear stress expressed as a function of the ratio of the injection velocity to the friction velocity, the form of the solution is particularly simple. The theory provides a free parameter which can be determined such that the available experimental data are excellently correlated. (Contractor's abstract)

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Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

ON THE RESPONSE OF THE LAMINAR BOUNDARY LAYER TO SMALL FLUCTUATIONS OF THE FREE-STREAM VELOCITY, by N. Rott and M. L. Rosenzweig. [1959] [27]p. incl. diagr. (AFOSR-TN-59-885) (AF 18-600)1523) Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 741-747; 787, Oct. 1960.

The linearized treatment of small time-dependent disturbances of a laminar boundary layer, initiated by Lighthill, is extended in several ways. In particular, the high-frequency expansion is continued beyond the leading (Stokes) term, which was the only one considered so far. Several interesting questions of "joining" occur, which are discussed but left unsolved. Also, a practical method for obtaining the response to an impulsive change in velocity is given. The application of the methods to the case when the basic flow belongs to the Falkner-Skan family is discussed. (Contractor's abstract)

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Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

AN INVISCID BOUNDARY LAYER OF MAGNETOHYDRODYNAMICS, by W. S. Lewellen. [1959] 46p. incl. diagrs. table. (AFOSR-TN-59-927) (AF 18(600)1523) AD 229791; PB 144767 Unclassified

A boundary-layer approximation for fluids with large electrical conductivities is applied to the 2-dimensional, steady, inviscid, incompressible magnetohydrodynamic equations for the case of a uniform magnetic field parallel to the free stream. Two approaches to the solution of the magnetic boundary layer are used: (1) the approximate integral method is used to derive equations analogous to the von Kármán integral momentum equation of viscous theory. These equations are integrated for flow of the type $U_1 = C x^n$; (2) the exact magnetic-boundary-layer equations are transformed, for similar flows, into a system of ordinary differential equations. The solution of these equations is found in the form of a power-series expansion in a parameter equal to the Alfvén speed divided by the free-stream velocity. Numerical results are given for several cases of similar

flow. In sub-Alfvénic flow, evidence points to a boundary layer growing in the direction opposite to the flow. (Contractor's abstract)

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Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

MAGNETOHYDRODYNAMIC EFFECTS IN AERODYNAMIC FLOWS, by W. R. Sears. [1959] [10]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1523] and Office of Naval Research) Unclassified

Presented at Thirteenth annual meeting of the Amer. Rocket Soc., New York, Nov. 17-21, 1958.

Published in ARS Jour., v. 29: 397-406, June 1959.

A review of the phenomena that appears in fluid motions if the fluid is a conductor and there are electric and/or magnetic fields present is discussed. Body forces, their origin, induced electromotive forces, and Joule heating are among the subjects discussed. Application of magnetohydrodynamics to aeronautical problems are suggested including the lift and drag of flying bodies, the transfer of heat from hot gas streams to adjacent bodies, and thrust production and augmentation. Areas of future investigation are also indicated.

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Cornell U. Graduate School of Aeronautical Engineering, Ithaca, N. Y.

ELECTROMAGNETIC INTERACTION WITH AERODYNAMIC FLOWS, by E. L. Resler, Jr. and J. E. McCune. [1959] [17]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)-1523] and Office of Naval Research) AD 241663 Unclassified

Published in Proc. Third Symposium on Magnetohydrodynamics, Lockheed Research Lab., Palo Alto, Calif. (Nov. 21-22, 1958), Stanford, Stanford U. Press, 1959, p. 120-136.

For steady flow past sinusoidal walls complete solutions to the linearized magneto-aerodynamic equations can be found for arbitrary values of the conductivity σ . From these the magnitude of the effects of current diffusion and Alfvén wave mechanism on the flow can be discerned. In general, both of these mechanisms are present in the flow; which of them dominates the forces on bodies depends on the geometry of the magnetic field. Therefore the criterion for whether or not a fluid will behave as a good conductor depends not only on the magnetic Reynolds number but also on the configuration. These mechanisms also appear in the theory of thin airfoils; in addition, they are modified importantly by compressibility effects. For the geometries considered,

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airfoil performance characteristics can be obtained in closed form for the general case. These solutions are analogous to the Prandtl-Glauert and Ackeret theories in conventional aerodynamics. (Contractor's abstract)

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**Cornell U. Graduate School of Aeronautical Engineering,
Ithaca, N. Y.**

SOME SOLUTIONS OF THE MACROSCOPIC EQUATIONS OF MAGNETOHYDRODYNAMICS, by W. R. Sears. [1959] [13]p. incl. diagr. refs. (AF 18(600)-1523) Unclassified

Published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 51-63. (AFOSR-TR-60-87)

A report is made on three different theoretical investigations concerning magnetohydrodynamics of inviscid incompressible fluids. These three studies concern the following cases: (1) Thin airfoils and slender bodies in fluids of modern conductivity; this to flows having uniform parallel magnetic and velocity fields in the undisturbed region. (2) An inviscid magnetic boundary layer; this is a nonlinear treatment for fluids of large but finite conductivity and also involves the case of uni-

form, parallel fields in the free stream. (3) Some flows involving tensor conductivity; here some flows previously studied, namely steady flow past a corrugated wall and one-dimensional wave propagation (Alfvén waves) are generalized for a fluid in which the Hall effect is appreciable.

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Cornell U. Sibley School of Mechanical Engineering,
Ithaca, N. Y.

A MULTIPLICATIVE MODEL FOR ANALYZING VARIANCES WHICH ARE AFFECTED BY SEVERAL FACTORS, by R. Bechhofer. July 10, 1959, 41p. incl. tables, refs. (Technical rept. no. 14) (AFOSR-TN-59-798) (AF 49(638)230) AD 226887 Unclassified

A multiplicative model is proposed for analyzing multifactor experiments which are conducted to study the effect of changes in the levels of the factors on the variance of a chance variable. The model is a direct analogue of the additive model for means. Univariate and multivariate applications to factorial experiments, experimental designs, and multiplicative response surfaces for variances are discussed. (Contractor's abstract)

Cruft Lab., Cambridge, Mass. see Harvard U. Cruft Lab.,
Cambridge, Mass.



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Delaware U. Dept. of Chemical Engineering, Newark.

TURBULENT FLOW AND HEAT TRANSFER RATES IN NON-NEWTONIAN FLUIDS, by A. B. Metzner. Final rept. Dec. 1959 [6]p. incl. diagrs. tables, refs. (AFOSR-TR-59-143) (AF 18(603)115) AD 230229
Unclassified

This research has been concerned with the analysis of the flow characteristics of non-Newtonian systems flowing through smooth round tubes, and the application of this knowledge to the prediction of heat transfer rates by means of the analogy between heat and momentum transfer. The results are summarized for turbulent flow pressure drop relationships, turbulent velocity profiles, and heat transfer rates. Item no. 477 is also bound with this report.

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Delaware U. [Dept. of Chemical Engineering] Newark.

HEAT TRANSFER TO TURBULENT NON-NEWTONIAN FLUIDS, by A. B. Metzner and P. S. Friend. [1959] [4]p. incl. diagrs. tables, refs. [AF 18(603)115]
Unclassified

Published in *Indus. and Eng. Chem.*, v. 51: 879-882, July 1959.

An analysis of turbulent heat transfer rates to fluids flowing in smooth round tubes is made. Extensive experimental data on slurries and polymer solutions are presented, covering the range of Prandtl numbers from 6.3 - 190, and of Reynolds numbers up to 71,000.

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Delaware U. Dept. of Chemical Engineering, Newark.

THE EFFECTS OF HIGH HYDROSTATIC PRESSURE ON SUBSEQUENT PHYSICAL PROPERTIES OF METALS, by J. R. Ferron. Dec. 11, 1959, 25p. incl. diagrs. tables. (AFOSR-TR-59-199) (AF 49(638)84) AD 272011
Unclassified

Studies were made of the changes in the physical properties of metals after the metals were treated at high hydrostatic pressure (200,000 psi maximum) for periods up to 3 wk. Treated and untreated samples of polycrystalline Mg and Al were tested in tension. No observable changes in strength properties occurred in either metal as a result of pressure treatment. Ductility of Mg was reduced slightly, but the effect is attributed to slight plastic deformation rather than to the pressure treatment itself. X-ray diffraction was used to study changes in single crystals of Al. No definite conclusions were drawn from the results because of low precision in the data. The x-ray studies are being continued to obtain more consistent results.

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Delaware U. Dept. of Physics, Newark.

[INTERMOLECULAR FORCE MEASUREMENTS BY MICROWAVE LINE WIDTHS], by H. F. Feeny. Final summary rept. Aug. 31, 1957 [6]p. incl. table. (Rept. no. PAR-19) (AFOSR-TR-59-96) (AF 18(600)449)
Unclassified

Measurements on the broadening of the J = 5 - 6 line of ammonia by H₂, O₂, N₂, and CO₂ have been completed. The molecular quadrupole moments of the various broadeners were calculated from the measured collision diameters and are compared to the quadrupole moments obtained from the J = 3 - 3 line width data. (Contractor's abstract)

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Detroit U. [Research Inst. of Science and Engineering] Mich.

DEVELOPMENT OF A MATHEMATICAL THEORY OF PLASTICITY BASED ON THE CONCEPT OF SLIP II, by H. Payne and S. J. Czyzak, and N. Bow. Oct. 1, 1959, 22p. incl. tables. (AFOSR-TN-59-1030) (AF 18(600)-1466) AD 229095; PB 144773
Unclassified

The model developed by H. Payne (*Jour. Mech. and Phys. Solids*, v. 7: 126, 1959) was used to solve the problem of a thin wall cylinder which is subjected to a torsional strain following a plaster tensile strain and the results of this work are described in detail. The study of the Bauschinger effect was started and the work contained in this report deals with the 1st phase of this study. The method for calculating the plastic behavior for a reversal of a uniaxial strain was developed and is discussed. (Contractor's abstract)

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Detroit U. [Research Inst. of Science and Engineering] Mich.

THE SLIP THEORY OF PLASTICITY FOR CRYSTALLINE AGGREGATES, by H. Payne. [1959] [9]p. incl. tables. (AF 18(600)1466)
Unclassified

Published in *Jour. Mech. and Phys. Solids*, v. 7: 126-134, Mar. 1959.

The model for predicting the plastic behavior of a crystalline aggregate under uniaxial stress from empirical data on slip in the single crystal which has been developed by Taylor and modified by Bishop and Hill, and by Lin is presented in a mathematical form which provides for the case in which the stress is not uniaxial. (Contractor's abstract)

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[Documentation, Inc., Washington, D. C.].

THE IBM 9900 SPECIAL INDEX ANALYZER, by R. W. Murphy. Nov. 17, 1958, 24p. incl. illus. diagrs. table. (AFOSR-TN-59-157) (In cooperation with International Business Machines Corp., Poughkeepsie, N. Y.) [AF 49(638)91] Unclassified

The IBM Special Index Analyzer is a machine designed to facilitate reference to cataloged information. It is composed of 3 units: a card punch which is used primarily for reading cards, a storage unit containing both the control equipment and a paper tape punch and reader for retaining the intermediate results of operations, and a typewriter for automatically printing the results of the search. An information retrieval system employing the Special Index Analyzer is set up on the basis that a document can be categorized by a set of terms. When items are entered into the system, each is analyzed to find which terms are pertinent to it, and records are made associating the item with significant items. The terms are drawn from a pre-established glossary. These records are then rearranged into an index consisting of subdivisions called term files, each of which includes all the references to which an individual term is pertinent. In this arrangement the term files are ready for use by the researcher, employing the IBM 9900 Special Index Analyzer to select out significant references automatically and accurately. The operations and applications of the machine are discussed in detail.

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Dublin Inst. for Advanced Studies (Ireland).

[HIGH-DENSITY HIGH-ENERGY ELECTRON SHOWERS AT SEA LEVEL]. Final technical rept. Dec. 1, 1956-Nov. 30, 1958, 16p. incl. tables, refs. (AFOSR-TR-59-54) (AF 61(514)1164) AD 216623; PB 143031 Unclassified

Experimental work on cosmic ray showers was carried out at stations in Dublin, Ireland, and Mona, Jamaica. The effects investigated were: (1) the variation in rate of local penetrating showers of the cosmic radiation with solar time; (2) the variation in rate of dense extensive air showers with solar time, together with related studies of shower size and structure; and (3) the variation in rate of penetrating extensive showers with sidereal time and the measurement of shower directions. The effect originally discovered in Dublin of the variation of rate with solar time was confirmed, and the results appear to be in reasonable agreement with the theory of Bassi and Ferrari. The variation in rate of showers with solar time was confirmed in Dublin and in Jamaica. The size of the showers producing the effect was shown to be between 10^6 and 10^7 particles at sea level. The hypothesis was introduced that the immediate cause of the effect is a change in the structure of the showers at sea level. The variation with side-

real time was confirmed in Dublin and a somewhat similar variation in rate of the penetrating extensive showers was found in Jamaica.

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Dublin Inst. for Advanced Studies (Ireland).

FURTHER EVIDENCE FOR A VARIATION IN THE RATE OF DENSE EXTENSIVE AIR SHOWERS WITH SOLAR TIME, by C. B. A. McClusker, D. E. Page, and R. A. Reid. [1959] [2]p. incl. diagr. refs. (AFOSR-TN-59-897) (AF 61(552)163) AD 225631 Unclassified

Also published in Phys. Rev., v. 113: 712-713, Jan. 15, 1959.

The variation in the rate of dense extensive air showers with solar time previously found in Dublin, Ireland, has been confirmed using a similar apparatus situated in Mona, Jamaica. It is suggested that this and other variations in rate with solar time may possibly be due to a periodic change in the structure function of the showers. (Contractor's abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

ON THE STEADY-STATE THERMOELASTIC PROBLEM FOR THE HALF-SPACE AND THE THICK PLATE, by L. N. Sneddon and F. J. Lockett. Mar. 1959 [11]p. incl. diagrs. (AFOSR-TN-59-301) (AF 13(600)-1341) AD 213085; PB 140460 Unclassified

Also published in Quart. Appl. Math., v. 18: 145-153, July 1960.

An attempt was made to determine the steady-state thermal stresses in a semi-infinite elastic medium and a thick elastic plate. The problem is treated as one in the classical theory of elasticity. The method of solution employed is that of multiple Fourier transforms, double transforms in this case. A general solution, corresponding to an arbitrary temperature field, is obtained in the form of 2-dimensional Fourier integrals, and it is confirmed that the stress field is plane and parallel to the boundary of the medium. The particular solution corresponding to axially symmetrical temperature fields is deduced. A solution is found for the problem in which the surface temperature is uniform over a circular region of exposure and is zero outside. In this special case an expression is given for the difference of the principal stresses in terms of tabulated integrals, and the 3-dimensional analogue of the constructed isochromatic lines. The corresponding analysis of the steady-state displacements and stresses produced by arbitrary distributions of temperature on the surfaces of a thick plate is given. To illustrate the use of the thick-plate formulae, the isochromatic surfaces within the plate are constructed for a special distribution of surface temperatures. (ASTIA abstract)

AIR FORCE SCIENTIFIC RESEARCH

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Duke U. [Dept. of Mathematics] Durham, N. C.

A NOTE ON THE AXIALLY SYMMETRICAL PUNCH PROBLEM, by I. N. Sneddon. Mar. 1959, 30. (AFOSR-TN-59-362) (AF 18(600)1341) AD 213672; PB 140534
Unclassified

The object of this report is to show that it is a simple matter to derive the form of the kernel function $K(\mu)$ appropriate to any prescribed displacement function $f(r)$. The results are in agreement with those of Segedin (Mathematika, v. 4: 156-161, Dec. 1957) who arrives at his solution by avoiding the use of dual integral equations and the introduction of an awkward system of curvilinear coordinates.

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Duke U. [Dept. of Mathematics] Durham, N. C.

THE ELEMENTARY SOLUTIONS OF SOME DUAL INTEGRAL EQUATIONS, by I. N. Sneddon. Mar. 1959, 5p. (AFOSR-TN-59-363) (AF 18(600)1341) AD 213673; PB 140535
Unclassified

Also published in Proc. Glasgow Math. Assoc., v. 4: 108-110, 1960.

A simple solution is given of the pairs of equations which arise most frequently in physical applications. The dual integral equations considered are of the type:

$$\int_0^\infty \xi^\alpha \psi(\xi) J_\nu(\xi \rho) d\xi = f(\rho), \quad 0 < \rho < 1; \text{ and}$$

$$\int_0^\infty \phi(\xi) J_\nu(\xi \rho) d\xi = 0, \quad \rho > 1, \text{ where } \alpha \text{ and } \nu \text{ are prescribed constants and } f(\rho) \text{ is a prescribed function of } \rho. \text{ (ASTIA abstract)}$$

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Duke U. [Dept. of Mathematics] Durham, N. C.

ON THE NUMERICAL SOLUTION OF A NON-LINEAR FIRST-ORDER DIFFERENTIAL EQUATION, by J. Douglas, Jr. Mar. 1959, 27p. incl. refs. (AFOSR-TN-59-403) (AF 18(600)1341) AD 214523; PB 142147
Unclassified

Also published in Proc. Rome Symposium on the Numerical Treatment of Partial Differential Equations with Real Characteristics, Rome (Italy) (Jan. 28-30, 1959), Rome, Libreria Eredi Virgilio Veschi, 1959, p. 12-16.

The initial value problem for the equation $u_t = g(u)v_x$ for $-\infty < x < \infty$, $t > 0$, where $u(x,0) = f(x)$, $-\infty < x < \infty$, is treated numerically. Under suitable assumptions on f

and g proof is presented of the convergence of a simple explicit finite difference scheme for the case in which the solution is discontinuous. (Math. Rev. abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

PROPAGATION OF THERMAL STRESSES IN A SEMI-INFINITE MEDIUM, by F. J. Lockett. Apr. 1959, 13p. incl. table, refs. (AFOSR-TN-59-498) (AF 18(600)-1341) AD 215923; PB 142359
Unclassified

Solutions are derived, using the classical theory of thermoelasticity, to the problem of the semi-infinite medium subjected to any physically possible combination of body forces, heat sources, surface tractions and thermal boundary conditions. The solutions are obtained in the form of multiple integrals over an infinite range, and in the general case they would have to be reduced by numerical procedures. A particular example is given in which the solutions reduce to a simple form. Results show that a stress component of physical importance differs from the classical value by a maximum amount of 5%. (Contractor's abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

SOME PROPERTIES OF THE FUNDAMENTAL SOLUTION OF THE PARABOLIC EQUATION, by S. M. Robinson. July 1959, 28p. incl. diagrams, refs. (AFOSR-TN-59-789) (AF 18(600)1341) AD 227717; PB 144374
Unclassified

Also published in Duke Math. Jour., v. 27: 195-220, June 1960.

The existence of a fundamental solution in both unbounded and bounded domains is proved for the parabolic equation: $L(u) = \sum_{i,j} a_{ij}(x_1, \dots, x_n, t) \frac{\partial^2 u}{\partial x_i \partial x_j} + \sum_{i,j} a_{ij}(x_1, \dots, x_n, t) \frac{\partial u}{\partial x_i} + a(x_1, \dots, x_n, t)u - \frac{\partial u}{\partial t} =$

0 , $(i,j = 1, \dots, n)$. Let the coefficients a_{ij} , a_{ij} , a_{ij} , and a be bounded and continuous functions of the variables x_1, \dots, x_n , t and satisfy uniform Holder conditions with respect to the space variables x_1, \dots, x_n . Assume that the quadratic form $\sum_{i,j} a_{ij} x_i x_j$, $(i,j = 1, \dots, n)$ is uniformly positive definite. In a domain Ω of Euclidean n -space, a fundamental solution of the parabolic equation is constructed. The domain need not be bounded, but may include all of Euclidean n -space. Several properties are derived, in particular, the fundamental solution is proved to satisfy the Chapman-Kolmogorov relation and also the equation adjoint to $L(u)$. (ASTIA abstract)

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Duke U. [Dept. of Mathematics] Durham, N. C.

THE STEADY-STATE THERMOELASTIC PROBLEM FOR THE ELASTIC LAYER RESTING ON A RIGID FOUNDATION, by I. N. Sneddon and F. J. Lockett. Sept. 1959 [11]p. incl. diagrs. (AFOSR-TN-59-1291) (AF 18(600)1341) AD 231226; PB 145508

Unclassified

Also published in *Ann. Math. Pura et Appl.*, v. 50: 309-317, 1960.

A determination is made of the steady-state thermal stresses in an elastic layer which is resting on a rigid frictionless foundation. The layer occupies the region $0 \leq z \leq d$, the surface $z = 0$ being free from stress and the surface $z = d$ being in contact with the foundation. This problem is unique in that the surfaces of the layer are not always completely free from stress. The condition $\sigma_z = 0$ on $z = d$ is not, in general, true, but is replaced by the condition that the normal displacement w should be zero at that surface. (It is assumed that the layer is prevented from separating from the foundation). The free surface of the layer is supposed to be subjected to a known temperature distribution $\varphi_1(x, y)$, while the rate of change of temperature $(\partial\theta/\partial z = \varphi_2(x, y))$ is known across the surface in contact with the foundation.

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[Duke U. Medical Center, Durham, N. C.]

THE MEASUREMENT OF HUMAN ADAPTATION TO STRESSFUL ENVIRONMENTS, by S. I. Cohen, A. J. Silverman, and B. M. Shmavonian. [1959] [11]p. incl. diagrs. (AFOSR-TN-59-142) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)354, Duke U. Regional Center for the Study of Aging, and Public Health Service) AD 264191

Unclassified

Presented at Thirteenth annual meeting of the Amer. Rocket Soc., New York, Sept. 15-18, 1958.

Also published in *Gen. Systems*, v. 4: 231-241, 1959.

The arousal state is ascertained by use of skin resistance measurements for the purpose of showing that the arousal state is related to psychophysiologic functions (particularly those which are associated with the capability to perform physical and psychological tasks). This relationship is, in fact, demonstrated; and in addition it is pointed out that those subjects who show the highest tolerance for stimuli, exhibit the least arousal before the stress, and those who, before stress application, show the higher level of arousal, cannot tolerate as high a level of stimuli. In addition to establishing the above relationship, it is also shown that skin resistance is re-

lated to other physiological changes, for instance hormonal and vascular changes. These observations, concerning water, mecholy, and adrenalin injections, show that the skin resistance measurements clarify the otherwise paradoxical results. Finally, the subject's own personal meaning of the stimuli (in the case of verbal stimuli) is taken into consideration, and the results show that the largest responses are given to those expressions which appear to be more meaningful to the subject. The implications drawn from these results indicate the need to consider a much broader evaluation of operational systems than just during stress periods. Furthermore, any complete analysis of behavior would have to include pre-stress conditions as well as comparison between response and average response for the same subject.

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[Duke U. Medical Center, Durham, N. C.]

HALLUCINATIONS IN SENSORY DEPRIVATION, by A. J. Silverman, S. I. Cohen and others. [1959] [10]p. incl. refs. (AFOSR-TN-59-143) (AF 49(638)354) AD 221902

Unclassified

Also published in *Proc. APA-AAAS Symposium on Hallucinations*, Washington, D. C. (Dec. 27-28, 1958), New York, Grune and Stratton, 1962, p. 125-134.

A systematic multi-disciplined investigation was initiated in order to study the response dissimilarities to various low sensory input environments. The experimental design included both the control of and variation of a number of factors considered relevant to response dissimilarities. Subjects exposed to isolation and sensory deprivation were questioned concerning their visual auditory, and kinesthetic sensations. The reports illustrated the difficulty encountered in differentiating ideas from fantasies, from visual imagery associated with fantasy, from illusory phenomena due to extraneous stimuli, or from visual imagery produced by body sensations.

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Duke U. Medical Center, Durham, N. C.

PRACTICAL AND THEORETIC DIFFICULTIES IN "ISOLATION" STUDIES, by S. I. Cohen, A. J. Silverman and others. [1959] [21]p. incl. refs. (AFOSR-TN-59-144) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)354, Duke U. Regional Center for the Study of Aging, and Public Health Service) AD 253126

Unclassified

Also published in *Proc. Symposium on Sensory Deprivation*, Harvard Medical School, Cambridge, Mass. (June 20-21, 1958), Cambridge, Harvard U. Press, 1961, p. 114-129).

Sensory deprivation and isolation involves a large number of variables related to (1) the subject, (2) the

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experimenter, and (3) the experimental situation. These variables are listed and described. Some examples are presented which suggest the kind of difficulties which may be created if these variables are not assessed. The variety of effects which may occur when one is exposed to the stress of isolation and sensory deprivation suggests that systematic interdisciplinary studies may be essential to fully realize the impact of the stress upon the subject and the kind of changes which may occur. The findings of 2 preliminary studies involving 14 subjects exposed to isolation and sensory deprivation are presented with the kind of theoretical problems which were provoked by the results of these studies. A multi-disciplined approach to the problems raised may permit a detailed investigation of the mechanisms mediating psychophysiologic relationships, and also clarify the factors responsible for the various responses which occur in this stressful environment.

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Duke U. Medical Center, Durham, N. C.

SELECTION TECHNIQUES FOR SPACE CREWS, by A. J. Silverman, S. I. Cohen, and B. Shmavonian. [1959] [6]p. (AFOSR-TN-59-145) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-354 and National Institute of Mental Health) AD 253128 Unclassified

Presented at Regional Research meeting of the Amer. Psychiat. Assoc., Miami, Fla., Dec. 1-3, 1958.

Also published in Amer. Jour. Psychiat., v. 115: 1110-1112, June 1959.

The criteria for crew selection is discussed including the problems of personality, motivation, and attitude. Of prime concern is the selection of those who will not respond with excessive startle and hyperalerting or panic to sudden emergencies. Thus a method of assessing CNS arousal and psychomotor functioning is important. Certain types of persons are considered undesirable, such as those with rebellious histories. It is pointed out that in the final analysis, concern with the ability of the central nervous system to rally and compensate to a stress and for the individual to maintain an ability to perceive and integrate external and internal stimuli and perform appropriate goal directed tasks is very important.

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Duke U. Medical Center, Durham, N. C.

INVESTIGATION OF PSYCHOPHYSIOLOGIC RELATIONSHIPS WITH SKIN RESISTANCE MEASURES, by A. J. Silverman, S. I. Cohen, and B. M. Shmavonian. [1959] [23]p. incl. diagrs. tables, refs. (AFOSR-TN-59-875) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)354, Public Health Service, and Wright-Patterson Air Force Base, Ohio under AF 18(600)1750) AD 233606 Unclassified

Also published in Jour. Psychosomat. Research, v. 4: 65-87, 1959.

Using a newly designed, highly sensitive and stable galvanic skin resistance (GSR) meter, basal resistance was found to be inversely related to arousal. Surgery on a dog showed an intact sympathetic nervous system is important, but blood volume shifts are not, in causing resistance drops. Moderate arousal (GSR) yielded the best tracking performance under hypotensive stress (human centrifuge). Heightened arousal had the greatest responsiveness to threshold electrical stimulation. Affectively charged words evoked arousal to the degree they had been psychiatrically judged most personally meaningful. GSR measures of arousal agreed with measured venous tone (12 Ss), blood pressure changes (15 Ss), and rises of adrenaline and noradrenaline in 15 Ss under verbal chastisement.

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE TO THE NUCLEIC ACIDS AND THEIR CONSTITUENTS, by H. Shields and W. Gordy. [1959] [31]p. incl. diagrs. (AFOSR-TN-59-53) (Bound with its Quarterly progress rept. no. 24, Nov. 1, 1958-Feb. 1, 1959; AD 212052) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)497 and Office of Ordnance Research) AD 209424 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 269-281, Feb. 1959.

As evidenced by the resonance signals, the radicals produced by irradiation of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) were different from those of any of their constituents. This suggested that radiation effects on the nucleic acids cannot be predicted from studies of mononucleotides. At room temperature the efficiency for production of detectable, long-lived radicals in the nucleic acids by ionizing radiations was low. The sharp peaking of the resonance of DNA and RNA indicated possible electron mobility or semiconductivity in the ionized acids. An O after-effect was absent. The resonance signal decreased with increase of temperature, indicating that thermal motions could assist electron recombination. The strong resonances obtained for the nucleic acids irradiated and observed at 77°K indicated that there was a high potential damage "frozen in."

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE TO CERTAIN LIPIDS, HORMONES, AND VITAMINS, by H. N. Rexroad and W. Gordy. [1959] [18]p. incl. diagrs. (AFOSR-TN-59-54) (Bound with its

AIR FORCE SCIENTIFIC RESEARCH

Quarterly progress rept. no. 24, Nov. 1, 1958-Feb. 1, 1959; AD 212052) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)497, and Office of Ordnance Research) AD 209425

Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 256-269, Feb. 1959.

Microwave electron-spin resonance was used to study radiation damage (Co^{60} γ -radiation) to certain lipids, hormones, and vitamins. Compounds irradiated included cholesterol, sitosterol, cholic acid, stigmasterol, ergosterol, progesterone, testosterone propionate, pregnenolone, hexestrol, parathyroid, thyroid, calciferol, biotin, riboflavin, riboflavin 5-phosphate Na, vitamin K-5, folic acid, ascorbic acid, Ca ascorbate, testosterone, and nicotinic acid.

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Duke U. Microwave Lab., Durham, N. C.

ABSORPTION AND DISPERSION OF MICROWAVES IN FLAMES, by J. Schneider and F. W. Hofmann. [1959] [34]p. incl. diagrs. table, refs. (AFOSR-TN-59-248) Bound with its Quarterly progress rept. no. 25, Feb. 1-May 1, 1959; AD 219115) (Sponsored jointly by Air Force Office of Scientific Research under AF 18-(600)497, California Research Corp., and Office of Naval Research) AD 212228

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 236, Apr. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 116: 244-249, Oct. 15, 1959.

The dependence of the high-frequency electric conductivity and the optical constants of a weakly ionized gas on the microwave frequency, the electron-molecule collision frequency, the electron concentration, and an external magnetic field are discussed. Measurements of the electric conductivity between 23.10 and 92.96 kmc/sec indicate that the effective electron-molecule collision frequency in an acetylene-air flame is independent of the electron velocity within the limits of error. Cyclotron resonance of free electrons has been found in low-pressure flames at 24 kmc/sec. This effect can be used to determine both the concentration of free electrons and the electron collision frequency.

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Duke U. Microwave Lab., Durham, N. C.

MILLIMETER-WAVE ROTATIONAL SPECTRUM OF NO IN THE $2\pi_{3/2}$ STATE, by P. G. Favero, A. M. Mirri,

and W. Gordy. [1959] [15]p. incl. diagrs. tables, refs. (AFOSR-TN-59-249) (Bound with its Quarterly progress rept. no. 25, Feb. 1-May 1, 1959; AD 219115) (AF 18-(600)497) AD 212229

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 290, Apr. 30, 1959.

Also published in Phys. Rev., v. 114: 1534-1537, June 15, 1959.

The $J = 3/2 - 5/2$ rotational transition of NO in the $2\pi_{3/2}$ electronic state has been measured in the 1.17 mm wave region. Theory applied to these measurements combined with previous measurements on transitions of the ground $2\pi_{1/2}$ state lead to the following values for the characteristic constants of $\text{N}^{14}\text{O}^{16}$: The rotational constant, $B_0 = 50, 848.42$ mc/sec, and the spin orbit coupling constant $A = 122.094$ cm^{-1} . The N^{14} nuclear magnetic couplings $a = 83.82$ mc/sec, $b = 68.49$ mc/sec, $c = 86.34$ mc/sec, and the N^{14} nuclear quadrupole couplings $eQq_1 = -2$ mc/sec, $eQq_2 = 22$ mc/sec. The Λ -doubling constants $p_A = 175.15$ mc/sec, $q_A = 1.15$ mc/sec. (Contractor's abstract)

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Duke U. [Microwave Lab.] Durham, N. C.

STIMULATED EMISSION OF RADIATION BY ELECTRONS IN A MAGNETIC FIELD: RELATIVISTIC EFFECTS, by J. Schneider. [1959] 8p. (AFOSR-TN-59-862) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)497) AD 235439

Unclassified

The proof of the equation:

$$W_j = m_0 c^2 \left(1 + 2(j + 1/2) \frac{\hbar \omega_c}{m_0 c^2} \right)^{1/2} - m_0 c^2$$

representing the energy levels of a relativistic electron in a magnetic field is shown. Summarily, mono-energetic electrons in a magnetic field can undergo stimulated emission of radiation if the width of the cyclotron resonance line is very small.

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Duke U. [Microwave Lab.] Durham, N. C.

STIMULATED EMISSION OF RADIATION BY ELECTRONS IN A MAGNETIC FIELD, by J. Schneider. [1959] [8]p. incl. diagr. (AFOSR-TN-59-863) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)497) AD 235439

Unclassified

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Monoenergetic electrons in a magnetic field undergoing absorption and emission are discussed. If the relaxation time is independent of the energy, the electrons will always absorb electromagnetic energy; however, if the relaxation time is energy dependent, the electrons undergo stimulated emission.

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Duke U. [Microwave Lab.] Durham, N. C.

STIMULATED EMISSION OF RADIATION BY RELATIVISTIC ELECTRONS IN A MAGNETIC FIELD, by J. Schneider. [1959] [4]p. incl. diagr. (AFOSR-TN-59-864) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)497) AD 235439
Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 504-505, June 15, 1959.

A formula is deduced for the cyclotron resonance curve for relativistic electrons. For small collision frequency a portion of the curve may lie below the frequency axis, i.e., there may be stimulated emission rather than absorption. The use of this effect in a new type of maser is mentioned.

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Duke U. [Microwave Lab.] Durham, N. C.

MILLIMETER WAVE SPECTRUM AND STRUCTURE OF FORMYL FLUORIDE, by P. [G.] Favero, A. M. Mirri, and J. G. Baker. [1959] [5]p. incl. tables. (AFOSR-TN-59-865) (Bound with its Quarterly progress rept. no. 26, May 1-Aug. 1, 1959) (AF 18(600)497) AD 235439
Unclassified

Also published in Jour. Chem. Phys., v. 31: 566-567, Aug. 1959.

The rotational spectrum of formyl fluoride was studied in the frequency range 90-160 kmc/sec. The spectrum observed indicates a planar molecule having parameters in good agreement with those obtained by electron diffraction.

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF ALANINE: SECOND-ORDER EFFECTS IN FREE RADICAL RESONANCES, by I. Miyagawa and W. Gordy. [1959] [48]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1208) (Bound with its [Quarterly progress] rept. no. 27, Aug. 1-Nov. 1, 1959) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)497] and Office of Ordnance Research) AD 235439
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 260, Apr. 30, 1959. (Title varies)

Also published in Jour. Chem. Phys., v. 32: 255-263, Jan. 1960.

The electron spin resonance of single crystals of l- and d-alanine has been observed at $T = 300^\circ\text{K}$ and analyzed for different orientations of the crystal in the magnetic field and at several microwave frequencies ranging from 9 kmc/sec to 34 kmc/sec. The stable free radical produced by the irradiation is proved to be of the form CH_3CHR , where R is a group which has no nuclei with detectable coupling. The hydrogens of the CH_3 group of the radical are shown to have equivalent, isotropic coupling of 26 gauss each, essentially independent of the frequency of observation. This CH_3 group coupling is interpreted as arising from s orbital spin density of the hydrogens, via hyperconjugation. The hydrogen of the CH group has both an isotropic, Fermi term, $A_1 = 20$ gauss, arising from s orbital density on the hydrogen, and an anisotropic term $A_\mu = 7$ gauss arising from dipole-dipole interaction of the proton moment with the electron spin density, ρ_C , on the carbon. Although the signs of A_1 and A_μ could not be learned, they are shown to be of opposite sign. Hence the spin density is negative on either H or C. Principal values of the CH coupling are $A_1 = 7$ gauss, $A_2 = A_3 = 27$ gauss. The value of ρ_C is shown to be 0.75 approx. For certain orientations of the crystal the CH coupling becomes equal to the CH_3 coupling, and a quintet pattern is observed. Interesting second-order transitions are observed which for the [001] orientation become in the region of 24 kmc/sec as strong as the normal first-order transitions. A general theory is developed which accounts satisfactorily for these second-order effects which are probably of consequence in the electron spin resonance patterns of numerous other free radicals trapped within solids. (Contractor's abstract)

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE STUDIES OF MECHANISMS FOR CHEMICAL PROTECTION FROM IONIZING RADIATION, by W. Gordy and I. Miyagawa. [1959] [48]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1209) (Bound with its [Quarterly progress] rept. no. 27, Aug. 1-Nov. 1, 1959) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)497] and Office of Ordnance Research) AD 235439
Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

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Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 384, Aug. 27, 1959. (Title varies)

Also published in Radiation Research, v. 12: 211-229, Mar. 1960.

Small concentrations of the sulfur-containing chemical protectors - cysteine, cysteamine, AET, glutathione, $\text{Na}_2\text{S}_2\text{O}_4$ - in solid solution in certain proteins are found to alter completely the form of the electron spin resonance produced by ionizing radiations in the proteins. For example, solutions of only 1/2 of 1% by weight of cysteine or $\text{Na}_2\text{S}_2\text{O}_4$ in zein (or 2 molecules of solute per protein molecule) produced resonances when γ -irradiated which are entirely different from that of pure zein when γ -irradiated. It is believed that these sulfur protectors form complexes with the proteins they protect and thus absorb the ionization or damage that would occur in the "unprotected" protein. The results indicate that an electron hole or electron spin density can migrate through certain segments of polypeptide chains of proteins. (Contractor's abstract)

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Duke U. [Microwave Lab.] Durham, N. C.

ELECTRON SPIN RESONANCE OF FREE RADICALS FORMED BY IRRADIATION OF AMINO ACIDS AND PROTEINS AT 77°K (Abstract), by F. Patten and W. Gordy. [1959] [1]p. [AF 18(600)497] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 290, Apr. 30, 1959.

When γ irradiated and observed at 77°K, many amino acids, peptides, and proteins were found to give electron spin resonance patterns which differ markedly from those obtained when the samples were irradiated at 300°K and then cooled to 77°K. When certain of these samples irradiated at 77°K were allowed to warm, their patterns at 300°K were found to become like those obtained by irradiation at 300°K. When these samples were cooled again to 77°K, they did not regain their original patterns. From these results it is concluded that temperature often influences strongly the kind of radicals produced or stabilized in organic solids and that the radicals observed at room temperature are often not the primary ones produced by the irradiation.

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Duke U. [Microwave Lab.] Durham, N. C.

HYPERFINE STRUCTURE IN THE ROTATIONAL SPECTRA OF FREE RADICALS (Abstract), by J. G. Baker. [1959] [1]p. [AF 18(600)497] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 290, Apr. 30, 1959.

A classical approach is used to derive the Hamiltonian for hyperfine interactions between rotation, unpaired electronic spins and nuclear spins in molecules of the free radical type. The method of Van Vleck is then applied in order to insert these interactions into the secular determinant giving the rotational energy levels. A slight modification in the normal diagonalization of the asymmetric rotor energy levels results in determinants of order up to $(2S + 1)$ for the hyperfine energy splittings corresponding to each value of the total angular momentum F . It is also possible to determine the Stark and Zeeman effects in the presence of this hyperfine structure. This theory has been used to give a partial explanation of the published microwave spectrum of NO_2 , and also in microwave studies of ClO_2 , the only remaining stable free radical for which no accurate structural determination exists. Further work on these 2 gases is now in progress in the millimeter wave region to obtain more detailed information about their molecular structure.

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Duke U. [Microwave Lab.] Durham, N. C.

DETERMINATION OF THE COLLISION FREQUENCY OF FREE ELECTRONS IN FLAMES BY MICROWAVE ABSORPTION MEASUREMENTS, by F. W. Hofmann, H. Kohn, and J. Schneider. [1959] 3p. (Bound with its Quarterly progress rept. no. 28, Nov. 1, 1959-Feb. 1, 1960) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)497] and Office of Naval Research under Nonr-118105) Unclassified

Also published in Zeitschr. Naturforsch., v. 14A: 998, Nov. 1959.

In order to determine the concentration of free electrons in flame gases from microwave attenuation measurements it is necessary to know the collision frequency ν of the electrons. A new determination of the electron collision frequencies in flames of different temperatures has been made. The frequency dependence of the attenuation was measured in the range between 23,100 and 92,960 mc, using 7 different frequencies. These measurements resulted in an electron frequency of $26 \times 10^{10} \text{ sec}^{-1}$. The shape of the dispersion curve indicated that, within the experimental error, the electron collision frequency is independent of the electron velocity. Subsequent measurements at 24,665 mc and at 48,250 mc with flames of various temperatures and compositions showed that ν does not depend strongly on the flame conditions. In a propane-air flame of 2100°K, ν was found to be $27 \times 10^{10} \text{ sec}^{-1}$. In acetylene flames of 2500°K and 2750°K a value of $\nu = 20 \times 10^{10} \text{ sec}^{-1}$ resulted in both cases.

AIR FORCE SCIENTIFIC RESEARCH

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Duke U. School of Medicine, Durham, N. C.

[BASIC MECHANISMS INVOLVED IN VASODEPRESSOR FAINTING], by J. V. Warren. Final rept. [1959] 10p. incl. refs. (AFOSR-TR-59-102) (AF 18(600)1542) AD 225127; PB 143505 Unclassified

A comprehensive study of the nature of vasodepressor syncope (the common faint) was undertaken. A critical review of the available information regarding this phenomenon was carried out. In addition, experimental studies aimed primarily at the circulatory nature of vasodepressor syncope and, in particular, dealing with the precipitating and predisposing factors, has lead to observations on the effects of various humoral substances such as norepinephrine on the vascular system, as well as the effect of drugs such as atropine and isoproterenol. Additional observations were made on the nature of abnormal heart sounds in a variety of clinical conditions. (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

THE EFFECT OF ATROPINE ON THE FLOW-TIME-PRESSURE RELATIONSHIPS IN THE CENTRAL AND PERIPHERAL VENOUS CIRCULATIONS, by R. J. Gorten, A. M. Weissler, and J. C. Gunnels. [1959] [2]p. [AF 18(600)1542] Unclassified

Published in Clin. Research, v. 7: 237-238, Apr. 1959.

Flow-time relationships in venous and central circulation before and after atropine administration were studied. Time concentration curves were determined from brachial arterial samples in supine, post-absorptive, young adult male subjects, following the simultaneous injections of indicator substances into the superior vena cava (T-1824) and an antecubital vein (iodinated I-131 albumin) before and 2 to 4 min after atropine sulfate (2 mg intravenously). Simultaneous outputs and mean circulation times (MCT) from central and peripheral venous sites were calculated. In 7 studies, in which simultaneously determined outputs from 2 injection sites agreed within 10%, atropine-induced augmentation averaged 46% (range 24 to 74%) over an average control index of 3.3 L/mm/M^2 (range 3.1 to 3.8) at a time when CVP diminished an average 2.0 mm Hg (range 0.3 to 3.4). When indicator was injected into antecubital vein, atropine shortened the MCT out of proportion to the increased cardiac output; with central injection, these 2 factors changed to the same degree. The amount of shortening of the MCT from the antecubital vein correlates well ($r = 0.73$) with accompanying falls in CVP. This finding indicates either a decrease in venous volume between the 2 injection sites or an uneven effect of atropine on the circulation, so that the rate of flow at the site of injection is increased out of proportion to the actual measured flow. If this

effect is a true volume shift, values in our study indicate this to be a decrease of 474 cc (range 260 to 710). (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

REFLEX VENOMOTOR ALTERATIONS DURING EXERCISE AND HYPERVENTILATION, by F. L. Merritt, Jr. and A. M. Weissler. [1959] [1]p. [AF 18(600)1542] Unclassified

Published in Clin. Research, v. 7: 238, Apr. 1959.

The vascular system of a forearm was isolated from the general circulation by a pneumatic cuff on the brachium inflated to suprasystolic levels. Simultaneous observations of pressure in such an isolated forearm venous segment and in the opposite antecubital vein and brachial artery were made in 14 normal subjects during a 15 to 30 sec interval of leg exercise on a bicycle ergometer. In each subject, an immediate pressor response in the isolated vein segment was noted with the beginning of exercise, reaching a peak level of 5 to 23 cm water (average -10 cm) in 10 to 30 sec and continuing 10 to 30 sec after completion of exercise. Venous pressure changes in the opposite unisolated antecubital vein were of similar direction but lesser magnitude. To separate the effects of some of the known components of exercise, observations of venomotor changes were made during hyperventilation, single deep inspiration, passive leg motion, emotional anticipation of exercise, and reactive hyperemia of the lower extremities. Only hyperventilation and single deep inspiration elicited consistent veno-constrictor activity, the magnitude of which approached but did not equal that seen during exercise. In 3 subjects an infusion of a ganglionic blocking agent (Arfonad) resulted in marked attenuation or complete obliteration of the reflex responses. (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

VASODEPRESSOR SYNCOPE, by A. M. Weissler and J. V. Warren. [1959] [9]p. [AF 18(600)1542] Unclassified

Published in Amer. Heart Jour., v. 5: 788-794, May 1959.

It was concluded in this report that vasodepressor (the common faint) is an acute episode characterized by a sudden loss of consciousness. It is associated with a fall in arterial pressure which may be attributed to a sudden decrease in peripheral resistance secondary to generalized vascular dilatation and occurring in a setting in which the heart fails to compensate normally by an increased output. As a consequence, there is an inadequate cerebral blood flow, leading to loss of

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consciousness. In apparent attempts to re-establish circulatory equilibrium, a marked but ineffectual autonomic display ensues, the afferent stimuli for which are as yet uncertainly known. The predominant picture is one of discoordinated circulatory responses which might best be termed "acute circulatory disorganization." (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

CIRCULATORY AND ELECTROENCEPHALOGRAPHIC CHANGES ASSOCIATED WITH LOSS OF CONSCIOUSNESS IN VASODEPRESSOR SYNCOPE (Abstract), H. R. Karp, A. M. Weissler, and A. Heyman. [1959] [1]p. [AF 18(600)1542] Unclassified

Presented at Fifty-first annual meeting of the Amer. Soc. for Clinical Invest., Atlantic City, N. J., May 4, 1959.

Published in Jour. Clin. Invest., v. 38: 1016, June 1959.

Recent interest in circulatory adaptation to rapid acceleration has led to a reinvestigation of the changes in arterial pressure, pulse rate and the electroencephalogram (EEG) as predictive indices of loss of consciousness in posturally induced vasodepressor syncope. Vasodepressor syncope was induced in 10 normal young male subjects by sodium nitrite (180 mg orally) combined with 60° head-up tilt. Continuous EEG recordings were made simultaneously with pulse and direct arterial blood pressure determinations. Before onset of syncope, the blood pressure showed a progressive reduction associated with autonomic dysfunction, e.g., sweating, pallor and nausea. Overt disturbances of mental function were a late phenomena and coincided with the appearance of sporadic low voltage theta waves in the EEG. Loss of consciousness developed 4 to 10 sec later and was accompanied by a profound reduction in mean arterial pressure to an average of 31 mm Hg (range, 22 to 42) and by high voltage delta waves in the EEG. At this time the mean arterial pressure had fallen approx 70% from control levels to a mean of 25 mm Hg and the cerebral blood flow, as estimated by cerebral arteriovenous oxygen differences, showed a 50% reduction. The development of bradycardia was a late but inconsistent finding. These studies demonstrate a remarkable adaptability of the central nervous system of normal subjects to withstand severe hypotension. The most reliable indices for predicting loss of consciousness appeared to be the appearance of theta activity in the EEG and a fall in mean arterial pressure below 45 mm Hg. (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

THE HEMODYNAMIC EFFECTS OF ISOPROTERENOL IN MAN WITH OBSERVATIONS ON THE ROLE

OF THE CENTRAL BLOOD VOLUME, by A. M. Weissler, J. J. Leonard, and J. V. Warren. [1959] [5]p. [AF 18(600)1542] Unclassified

Published in Jour. Lab. and Clin. Med., v. 53: 921-925, June 1959.

The cardiac output responses to a constant infusion of isoproterenol (Isuprel, isopropyl norepinephrine) were studied in normal subjects in the recumbent and passive head-up tilt postures. Significant elevations in cardiac output and stroke volume associated with slight increases in pulse rate were observed in recumbent subjects. In tilted (head-up) subjects the minute and stroke volume responses to isoproterenol infusions were of significantly less magnitude, while the pulse rate increases were of similar degree. These data are consistent with the view that as a consequence of the peripheral pooling of blood and depletion of the thoracic reservoirs in the upright posture, there is limitation on cardiac output and stroke volume responsiveness. This effect is less, however, with an agent (isoproterenol) having a positive inotropic action than with one acting predominantly on heart rate (atropine). (Contractor's abstract)

516

Duke U. School of Medicine, Durham, N. C.

PULMONARY BLOOD VOLUME DETERMINED BY A RADIOACTIVE TRACER TECHNIQUE, by A. M. Weissler, B. H. McGraw, and J. V. Warren. [1959] [4]p. [AF 18(600)1542] Unclassified

Published in Jour. Appl. Physiol., v. 14: 531-534, July 1959.

In the present study, a semi-quantitative technique for assaying shifts in intrapulmonary blood volume is described. The method consists of the external monitoring of radioactivity over the anterior thorax after the intravenous administration of radioactive iodinated albumin utilizing a sensitive scintillation counter with a focussing collimator attachment. While this method does not yield the quantitative data of the indicator dilution and body plethysmographic techniques, it offers the advantage of confining observations to the intrapulmonary rather than the intrathoracic blood volume. Employing this technique the effects of the upright posture, peripheral venous pooling and the Valsalva maneuver have been studied. A fall in estimated pulmonary blood volume was noted with each procedure averaging 28%, 9% and 11%, respectively, below control levels. (Contractor's abstract)

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Duke U. School of Medicine, Durham, N. C.

CARDIOVASCULAR RESPONSES IN EXPERIMENTALLY INDUCED ALTERATIONS OF AFFECT, by M.

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D. Bogdonoff, J. J. Combs, Jr. and others. [1959] [7]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1542 and National Institutes of Health) Unclassified

Published in Circulation, v. 20: 353-359, Sept. 1959.

Although alterations in emotional arousal have long been associated with changes in cardiovascular dynamics, the precise quantitative relationship has not been

fully detailed. Independent assessment of the emotional change was felt to be a necessary component of a quantitatively oriented study. The variously described responses for "anxiety" and "anger" might better be re-explored in such a manner. The emotional arousal was experimentally produced in the laboratory. Measures of pulse, arterial blood pressure, and cardiac output were conducted both before and during the change in affect evoked by the laboratory stimulus. (Contractor's abstract)



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Enrico Fermi Inst. for Nuclear Studies, Chicago, Ill.
see Chicago U. Enrico Fermi Inst. for Nuclear Studies,
Ill.

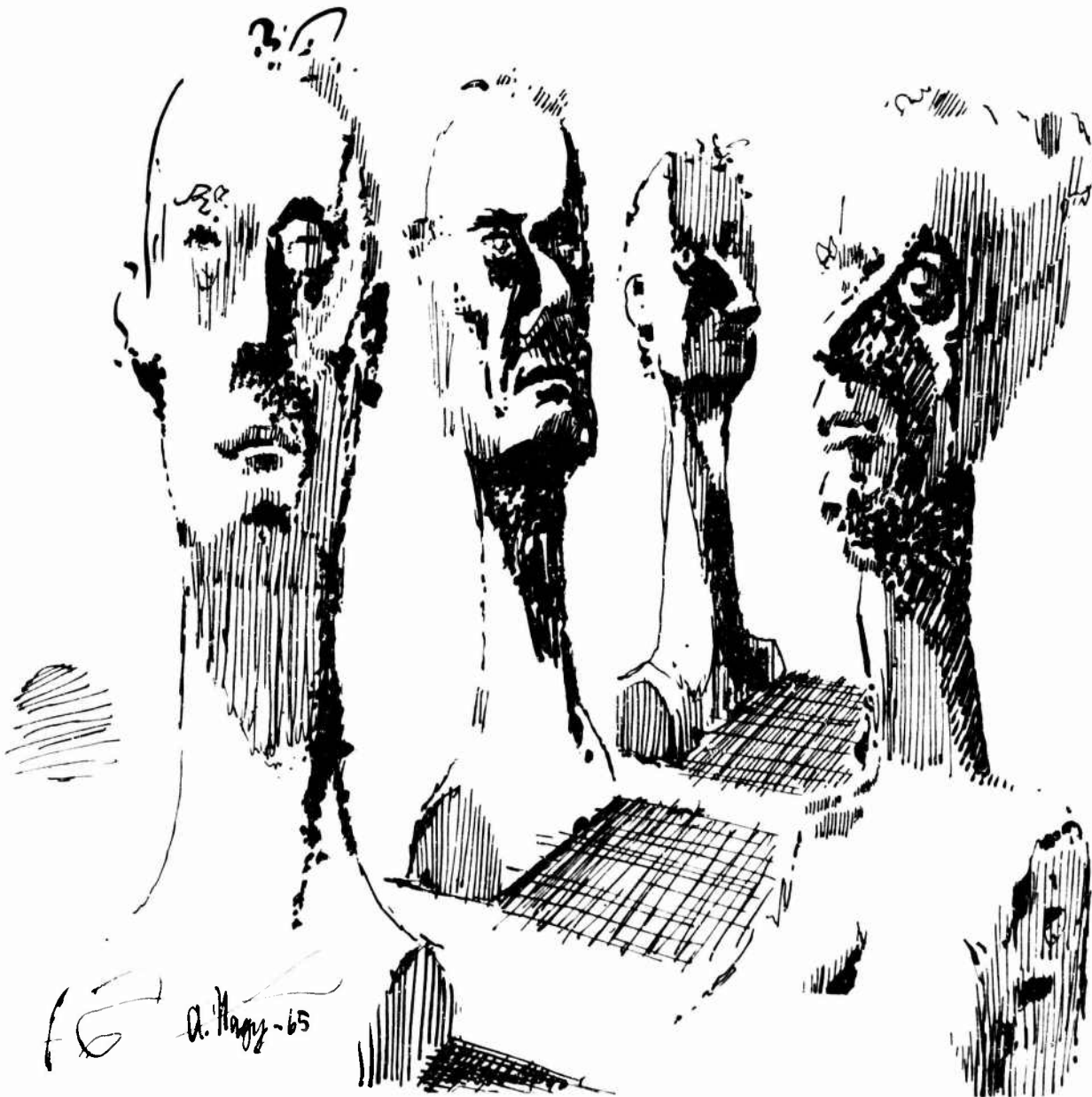
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Experiment, Inc., Richmond, Va.

THE SPARK IGNITION OF DUST CLOUDS, by L. E.
Line, Jr., H. A. Rhodes, and T. E. Gilmer, Jr. [1959]
[5]p. incl. diagrs. table, refs. (AF 18(600)1508)
Unclassified

Published in Jour. Phys. Chem., v. 63: 290-294,
Feb. 1959.

The spark ignition of lycopodium dust clouds suspended in oxygen-nitrogen mixtures has been studied under controlled conditions. Unlike homogeneous fuel-air mixtures, the spark ignition of lycopodium cannot be characterized solely by a minimum spark ignition energy as determined in the usual way for gases. This energy appears to be strongly dependent upon the electrical characteristics of the spark circuit that affect the discharge time. As the discharge time increases, the ease of ignition (measured by the min oxygen concentration or min stored condenser energy for ignition) goes through a max. A tentative explanation for the increase in ease of ignition is put forward in terms of the disturbance of the dust cloud by the spark discharge prior to ignition. Data comparing the ease of igniting confined and unconfined dust clouds also are presented and discussed.



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[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

PROPERTIES OF OBLIQUE DETONATION WAVES, by W. Chinitz, L. C. Bohrer, and K. M. Foreman. Apr. 15, 1959, 1v. incl. diagrs. table. (AFOSR-TN-59-462) (AF 49(638)15) AD 215267; PB 142018 Unclassified

The 2-dimensional steady flow equations for oblique detonation waves are solved for the conditions across the wave in terms of the initial Mach number, the heat addition, and the wave angle. Using an IBM digital computer, the resulting equations are solved over a range of the independent variables. Graphs are presented which show the results of this computation. (Contractor's abstract)

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

EXPLORATORY STUDIES OF COMBUSTION IN SUPERSONIC FLOW, I. PLANE DETONATION WAVES. II. OBLIQUE DETONATION WAVES, by R. A. Gross. June 15, 1959, 56p. incl. illus. diagrs. refs. (AFOSR-TN-59-587) (AF 49(638)15) AD 216769; PB 142039 Unclassified

Methods for releasing chemical energy in supersonic flow were investigated. A study was made of (1) standing-stable detonation waves, both strong and Chapman-Jouguet types, (2) standing-stable oblique detonation waves, (3) combustion in a boundary layer on a flat plate immersed in a supersonic stream, (4) combustion behind a wedge-shaped flame holder in supersonic flow, and (5) thermal ignition properties of mixtures of hydrogen with air and methane with air. An ignition hysteresis effect was found which permitted the detonation studies to be conducted over a wide range of initial stagnation temperatures. The detonation wave front was remarkably plane, although the flow field immediately behind the wave was subsonic and complex. Steady oblique detonations were produced in the supersonic test section. These waves also exhibited the ignition hysteresis effect. However, the flow field downstream of the wave was, under many conditions, still supersonic.

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

SOME PROPERTIES OF A HYDROGEN PLASMA, by C. L. Eisen and R. A. Gross. June 1959 [37]p. incl. diagrs. (AFOSR-TN-59-588) (AF 49(638)15) AD 216770; PB 144449 Unclassified

Also published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases,

Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 15-24. (AFOSR-TR-60-87)

The chemical equilibrium composition of a hydrogen mixture is determined over the temperature range from 10^3 °K to 10^6 °K and pressures from 10^{-6} to 10^6 atm. The species recognized are, H_2 , H, H^+ , H^- and e^- .

Equilibrium and frozen values of γ , C_p and the speed of sound are presented in the dissociation and ionization regimes. Electrical conductivity and bremsstrahlung power radiation data are also given. (Contractor's abstract)

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

A DETONATION WAVE HYPERSONIC RAMJET, by W. H. Sargent and R. A. Gross. June 1959, 40p. incl. illus. diagrs. refs. (AFOSR-TN-59-589) (AF 49(638)15) AD 216811; PB 142244 Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass. (Oct. 7-8, 1959), Boston, v. 2: 3-28, 1959. (AFOSR-637)

Also published in ARS Jour., v. 30: 543-549, June 1960.

This report examines the performance of a hypersonic ramjet having a detonation wave combustion process. Flight speeds from Mach 2.5 to 10 are examined. Engine performance characteristics are presented and compared with those of a conventional ramjet. (Contractor's abstract)

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[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

A DIRECT NUCLEAR ELECTROGENERATOR. ANALYSIS OF CYLINDRICAL ELECTRODE CONFIGURATION, by A. Schock. June 15, 1959, 139p. incl. diagrs. tables, refs. (AFOSR-TN-59-590) (AF 49(638)15) AD 216812 Unclassified

A system for the direct conversion of nuclear fission energy to high voltage electricity is examined. The system is based on the motion of highly charged fission fragments counter to a strong electric field. In this manner, part of the fragments' kinetic energy is converted into potential (electric) energy. The superiority of cylindrical over plane electrodes is explained, and the effect of various geometric and operating variables on system performance is analyzed. For various conditions, it is possible to achieve conversion efficiencies up to 13%, electric power densities up to 4.5 megawatts/cm of reactor core, and neutron multiplication factors

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up to 2.1. However, these 3 performance parameters are shown to be mutually interdependent, and the choice of a design point must represent a compromise between their respective maximization. The optimum design parameters will depend on the intended application of the system. (Contractor's abstract)

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[Fairchild Engine and Airplane Corp.] Fairchild Engine Div., Deer Park, N. Y.

RESEARCH ON SUPERSONIC COMBUSTION, by R. A. Gross. [1959] [2]p. incl. illus. diagr. (AF 49(638)15)
Unclassified

Published in ARS Jour., v. 29: 63-64, Jan. 1959.

A means of releasing chemical energy steadily in supersonic flow was devised to study combustion waves and their stability. It was found possible to produce strong steady detonations at very high propagation speeds, with fast chemical reaction rate, with wide fuel-oxidizer combustion capability, and with high heat release rate.

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

SMOOTH INTERPOLATION, by T. J. Rivlin. [1959] [4]p. (AF 49(638)15)
Unclassified

Published in SIAM Rev., v. 1: 60-63, Jan. 1959.

Given n distinct points (x_i, y_i) , $i = 1, \dots, n$, there is a unique polynomial of degree n , $P(x)$, which passes through these points and for which the arc length $\int_{x_1}^{x_n} (1 + (P'(x))^2)^{1/2} dx$ is minimum. This polynomial is called a "smooth" interpolant, and is determined in terms of the zero of a certain transcendental equation. Several examples are presented which were computed from an IBM 650 program. (Math. Rev. abstract)

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

RESEARCH ON SUPERSONIC COMBUSTION, by R. A. Gross. Final rept. Apr. 1-June 30, 1959, 5p. incl. refs. (Technical status rept. no. 11) (AF 49(638)15)
Unclassified

This report summarizes the additional experimental aerothermodynamic data gathered to date on standing, normal detonation waves. The experiments included installing a remote activated movable probe in the

supersonic section. Axial and vertical distribution of the fuel/air ratio, total pressure, total temperature and products of combustion data were obtained. Detonation waves were also obtained by using methane and air. These possess the same general considerations as the hydrogen detonation. Spectroscopic studies were conducted to examine the molecular changes in properties across the wave. Oblique detonation waves were also generated, observed, and definitely confirmed in the supersonic tunnel for the 1st time.

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Fairchild Engine and Airplane Corp. Fairchild Engine Div., Deer Park, N. Y.

A HIGH-TEMPERATURE, STEADY-FLOW, SUPERSONIC TUNNEL, by R. A. Gross. [1959] [2]p. incl. illus. table. (AF 49(638)15)
Unclassified

Published in Jour. Aero/Space Sci., v. 26: 676-677, Oct. 1959.

Details of the construction, characteristics, and operating experiences with this tunnel are described. The tunnel is designed to function at M3 and has a flow area of 3×6 in. When initial operating experience showed that the heat transfer design was conservative, a hydrogen injection system was installed in the plenum chamber. By burning the hydrogen, a max operating temperature of 4800°F can theoretically be obtained. The present manual control permits a temperature change of 1000°F per sec.

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Florida State U. Dept. of Mathematics, Tallahassee.

OPENNESS OF THE DERIVATIVE OF A COMPLEX FUNCTION, by R. L. Plunkett. Sept. 1959, 8p. (AFOSR-TN-59-1120) (AF 49(638)598) AD 231818; PB 145769
Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 671-675, Oct. 1960.

Using the results and techniques of topological analysis, the openness of the derivative of a complex function is proved here in 2 ways, each dependent on the uniform differentiability of any differentiable function on compact subsets of its region of definition. (Contractor's abstract)

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Florida State U. [Dept. of Physics] Tallahassee.

"OVER AND UNDER" MAGNETIC ANALYZER. Sept. 1959, 8p. incl. tables. (Technical note no. 1) (AFOSR-2870) (AF 49(638)427)
Unclassified

AIR FORCE SCIENTIFIC RESEARCH

By mounting 2 magnetic spectrometers 1 above the other such that they may rotate with respect to each other and with respect to the beam, yields of charged particles with radically different gyromagnetic ratios or momenta may be simultaneously measured at 2 independent angles. Thus, precision excitation curves and angular distributions may be taken for any 2 charged particle exit channels. In the energy range of the tandem Van de Graaff accelerator, at least 2 such channels are open. Ambiguities in nuclear energy level parameters are often removed more easily by observing the angular distribution of 2 reaction products than by detailed study of 1 product. In addition to this unique advantage, many of the advantages of the conventional multi-angle magnets accrue at a fraction of the capital outlay. When broad range analyzers are used for the component magnets, several exit channels may be simultaneously detected in each analyzer, or the device may be used as a 2 angle broad range spectrograph. Design characteristics for the magnetic analyzer and a research program using this analyzer in conjunction with the Florida State U. tandem Van de Graaff accelerator are presented. (Contractor's abstract)

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Florida State U. [Dept. of Physics] Tallahassee.

EVIDENCE FOR COLLECTIVE EXCITATION IN

Ca^{40} (Abstract), by R. H. Davis. [1959] [1]p. [AF 49-638)427] Unclassified

Presented at meeting of the Amer. Phys. Soc., Loyola U., New Orleans, La., Apr. 9-11, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 387, Aug. 27, 1959.

In spite of the doubly closed shell structure of Ca^{40} , the interpretation of the excited states of this nucleus in terms of the shell model is somewhat unsatisfactory because of the need to invoke a 2-nucleon excitation to

explain the O^+ first excited state and lack of uniqueness in the assignments for higher states. The low-lying states may also be interpreted as vibrational states

according to the collective model, but again the O^+ first excited state requires some refinement in the model, unless it is simply a breathing mode excitation. Evidence for collective effects in the first 3 states is found in the correlation between excitation energies of states observed in the elastic scattering of protons from Ca^{40} with those observed in the inelastic proton scattering experiments. Maxima in the inelastic scattering strength closely correspond to a recurrence of the low-lying states in Sc^{41} above a Ca^{40} core in 1 of its first 3 excited states. This correlation is simply explained if the core states are collective in character.

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Florida State U. Dept. of Physics, Tallahassee.

ON THE IMAGINARY OPTICAL POTENTIAL, by R. H. Lemmer, T. A. J. Maris, and Y. C. Tang. [1959] [6]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)427] and Atomic Energy Commission) Unclassified

Published in Nuclear Phys., v. 12: 619-624, Sept. 1959.

The imaginary part of the nuclear optical potential for nucleons is investigated in a semi-quantitative way. For simplicity, harmonic oscillator wave functions have been used to perform calculations for O^{16} and Ca^{40} . Results indicate that surface absorption is quite important for incident energies up to about 60 mev.

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Florida U. Dept. of Chemistry, Gainesville.

THE FORMATION OF LINEAR POLYMERS FROM DIENE MONOMERS BY A CYCLIC POLYMERIZATION MECHANISM. III. A STUDY OF THE STRUCTURE OF CYCLIC POLYMERS OF CERTAIN UNSYMMETRICAL 1,5- AND 1,7-DIENES, by M. D. Barnett, A. Crawshaw, and G. B. Butler. [1959] [4]p. incl. diagrs. tables, refs. (AFOSR-TN-59-431) (AF 18(603)116) AD 214793 Unclassified

Presented at meeting of the Polymer Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of papers, 1959, p. 17-S.

Also published in Jour. Amer. Chem. Soc., v. 81: 5946-5949, Nov. 20, 1959.

The methyl alkyl, methyl 2-butenyl and methyl 3-butenyl mixed esters of maleic and fumaric acid have been synthesized and polymerized in bulk using benzoyl peroxide to afford a series of low molecular weight linear polymers containing 37-77% residual unsaturation. The properties of the polymers indicated that polymerization had occurred by an intramolecular-intermolecular mechanism leading, in part, to a poly-[3(5)-methylene-4-carbomethoxy- δ -valerolactone] or (in the case of the 3-butenyl esters) to a poly-[3(5)-methylene-4-carbomethoxy- ϵ -caprolactone] structure. In addition, poly-(methyl allyl maleate) and poly-(methyl 2-butenyl maleate) showed absorption at 1780 cm^{-1} characteristic of a γ -butyrolactone ring system. This band was lacking in the corresponding fumarates. Possible explanations of the various modes and relative degrees of cyclization in the polymers are presented. (Contractor's abstract)

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Florida U. Dept. of Chemistry, Gainesville.

THE FORMATION OF LINEAR POLYMERS FROM DIENE MONOMERS BY A CYCLIC POLYMERIZATION MECHANISM. IV. THE SYNTHESIS AND POLYMERIZATION STUDIES OF SOME DOUBLY-UNSATURATED, UNSYMMETRICAL MONOMERS, by M. D. Barnett and G. B. Butler. May 1960 [2]p. incl. tables. (AFOSR-TN-59-810) (AF 18(603)116) AD 240034

Unclassified

Also published in Jour. Org. Chem., v. 25: 309-310, Feb. 1960.

Allyl crotonate (Ia), crotyl crotonate (Ib), β -methallyl crotonate (Ic), propargyl crotonate (Id), N-allyl crotonamide (Ie), allyl vinylacetate (IIa), crotyl vinylacetate (IIb), and β -methallyl vinylacetate (IIc) were prepared. Polymerization experiments were carried out in bulk under dry nitrogen with 5- to 10-g monomer samples and 2 wt-% of either benzoyl peroxide or azobisisobutyronitrile as initiators. Benzoyl peroxide-initiated reactions were run at 100°; those initiated by azobisisobutyronitrile were maintained at 75°. Only Ia and Ic gave solid, titratable polymers; Ib, IIb, and Ie gave no polymeric material; IIa, IIc and Id afforded only viscous oils which resisted crystallization. Gel time for Ia was 110 hr; there was no gelation for Ic after 32 days at 100° with 2 wt-% Bz_2O_2 . Cyclization values were 25 and 31% for Ia and Ic, respectively. This is reflected in the great difference in reactivities between the alcohol and acid bonds; values for residual alcohol and acid bonds of Ia and Ic are 15% (alcohol), 60% (acid) and 11% (alcohol) and 58% (acid), respectively. Infrared spectroscopy revealed absorption in the C = C stretching (1640 to 1655 cm^{-1}) and carbonyl (1725 to 1740 cm^{-1}) regions and a strong band at 1770 to 1772 cm^{-1} characteristic of a 5-membered lactone ring.

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Florida U. Dept. of Chemistry, Gainesville.

A STUDY OF POLYMERIZATION BY AN ALTERNATING INTRAMOLECULAR-INTERMOLECULAR CHAIN PROPAGATION MECHANISM, by M. D. Barnett. Final rept. Sept. 16, 1956-Sept. 15, 1959, 8p. incl. tables. (AFOSR-TR-59-146) (AF 18(603)116) AD 228268; PB 145435

Unclassified

The peroxide-initiated polymerization of diallyl- and diallyldimethylammonium bromide has given saturated, linear, soluble polymers containing recurring N-substituted piperidinium halide units alternating along the chain with methylene groups. The structure of the polymers was confirmed by degradative cleavage of the piperidinium rings. Acrylic anhydride has been polymerized in solution to afford a series of saturated, linear polymers whose molecular weights ranged from

a few thousand up to 95,000. The properties of the polymers showed that polymerization had occurred by an intramolecular-intermolecular mechanism leading to a poly[3(5)-methylene-glutaric anhydride] structure. The poly[acrylic acid] obtained by hydrolysis of a poly[acrylic anhydride] was shown by x-ray diffraction patterns to have a much more regular structure than normal poly[acrylic acid]. Poly[methacrylic anhydride] has been prepared from methacrylic anhydride and found to have properties similar to poly[acrylic anhydride]. The methyl allyl, methyl 2-butenyl, and methyl 3-butenyl mixed esters of maleic and fumaric acid have been synthesized and polymerized in bulk to afford a series of low molecular weight polymers containing 37-77% residual unsaturation. This indicated that the approximate percent cyclization in the various polymers ranged from 23 to 63%. Although the cyclic portions of the polymers were composed predominately of 6- and 7-membered lactone rings, the infrared spectra of poly[methyl allyl maleate] and poly[methyl 2-butenyl maleate] also showed the presence of 5-membered lactone rings. Several unsymmetrical dienes were prepared and subjected to free-radical polymerization conditions. (Contractor's abstract)

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Fordham U. Dept. of Chemistry, New York.

NUCLEOPHILIC REACTIONS OF SEMIIONIC OXYGEN. II. A NOVEL PREPARATION OF ETHYL GLYOXYLATE FROM ETHYL BROMOACETATE AND DIMETHYL SULFOXIDE. THE STOICHIOMETRY AND THE SULFUR-CONTAINING BY-PRODUCTS, by J. M. Tien and I. M. Hunsberger. Technical status rept. no. 11, pt. VI, Mar. 1-May 31, 1959, 4p. incl. refs. (AFOSR-TN-59-570) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)127 and Public Health Service) AD 264111

Unclassified

Presented in part at meeting of the Org. Chem. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 134th meeting of the Amer. Chem. Soc. Abstracts of papers, 1958, p. 75-P.

The reaction of excess dimethyl sulfoxide with ethyl bromoacetate produced ethyl glyoxylate, hydrogen bromide, and dimethyl sulfide. A convenient preparation of ethyl glyoxylate in yields averaging 70% was developed. The generality of the dimethyl sulfoxide oxidation was demonstrated by applying it to a variety of α -halogenated acids and esters. An ionic mechanism for this oxidation is suggested which involves nucleophilic displacement of the halogen by the sulfoxide oxygen. A number of earlier-reported reactions of sulfoxides also appear to depend on the nucleophilic nature of their oxygen atoms. It is suggested that other compounds containing semionic oxygen will exhibit analogous reactions. (Contractor's abstract)

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Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

DETERMINATION OF NUCLEAR DISINTEGRATION ENERGIES, by C. E. Mandeville, D. M. Van Patter and others. Final rept. Nov. 1, 1954-Oct. 31, 1958 [15]p. incl. diagr. refs. (AFOSR-TR-59-28) (AF 18(600)-1320) AD 211322 **Unclassified**

The precise determination of nuclear disintegration energies is being sought using a magnetic spectrometer for charged particles in conjunction with the ONR-Bartol Van de Graaff accelerator. Investigations were made of nuclear reactions caused by the bombardment by 1.5 to 5.0 mev protons of the following nuclei:

Al²⁷, P³¹, Cl³⁵, Cl³⁷, Cr⁵⁰, Cr⁵², Cr⁵³, Cr⁵⁴, Zn⁶⁴, Zn⁶⁶ and Zn⁶⁸. In several cases, the excitation curves for inelastic proton scattering were observed over a limited range of bombarding energies. Contributions have been made with respect to the compilation of nuclear reaction energy data, and the comparison of masses obtained from mass spectroscopy and nuclear reaction data. An attempt to understand some of the results of the experimental results obtained for inelastic proton scattering has resulted in a systematic study of the data available concerning the properties of low-lying levels of even-even nuclei, particularly those in the medium weight range. This study has revealed new possible trends which are of considerable theoretical interest.

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Franklin Inst. Bartol Research Foundation, Swarthmore, Pa.

E2-M1 MIXING RATIOS IN 2'-2-0 TRANSITIONS, by S. S. Malik, V. R. Potnis, and C. E. Mandeville. [1959] [5]p. incl. diagrs. table. [AF 49(638)512] **Unclassified**

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 233, Apr. 30, 1959.

Published in Nuclear Phys., v. 11: 691-695, June 1959.

The results of 12 published angular correlation experiments have been analyzed, and the E2-M1 mixing ratios of the 2'-2 transitions have been obtained for 12 different even nuclei. Particular attention has been given to evaluation of the errors in the measured values of the mixing ratios. The available data range from A = 56 to A = 198. When $(\delta/E_\gamma)^2$ is plotted against $Z^2 A^{4/3}$, three of the experimentally observed points, those for

Fe⁵⁶, Zr⁹² and Hg¹⁹⁸, deviate sharply from a curve calculated from the theoretical considerations of Davydov and Filippov. (Contractor's abstract)

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[Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.]

PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON GAS-LUBRICATED BEARINGS, Washington, D. C. (Oct. 26-28, 1959), ed. by D. D. Fuller. Washington, Office of Naval Research, 1959, 617p. incl. illus. diagrs. tables, refs. (AFOSR-1001) (Sponsored jointly by Air Force Office of Scientific Research, Army Engineer Research and Development Labs., Atomic Energy Commission, Bureau of Aeronautics, Bureau of Ordnance, Bureau of Ships, Maritime Administration, National Aero-Research, and Wright Air Development Center) **Unclassified**

This symposium was the first to be devoted exclusively to broad international scientific coverage of gas-lubricated bearings. In addition to United States participation, 8 or more foreign countries, as well as Asia were represented. Twenty papers were presented covering the progress of theoretical and experimental research on lubricated bearings at home and abroad. It was suggested that the gas-lubricated bearing has the potential for years of reliable, frictionless operation with virtually no maintenance. This would be particularly essential in the operation of manned satellites and space vehicles.

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Franklin Inst. Labs. for Research and Development, Philadelphia, Pa.

ETCH PATTERNS IN ZINC, by V. V. Damiano and M. Herman. Interim rept. July 1959, 21p. incl. illus. diagrs. (Rept. no. I-A1878-3) (AFOSR-TN-59-133) (AF 18(600)1581) AD 210861; PB 143674 **Unclassified**

Also published in Jour. Franklin Inst., v. 267: 303-315, Apr. 1959.

Loops and spiral etch patterns were observed on surfaces parallel or nearly parallel to the basal plane of zinc. Their motion and growth were recorded and appeared similar to the mechanism proposed by Frank and Read (Phys. Rev. v. 79: 722-723, 1950) for the generation of dislocations. These observations have been tentatively interpreted as the dissolution of a step in the surface with the end of the steps pinned. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

CELLULAR SUBSTRUCTURE IN ZINC CRYSTALS
GROWN FROM THE MELT, by V. V. Damiano and M.
Herman. Interim rept. Aug. 1959, 20p. incl. illus.
diags. refs. (Rept. no. I-A1878-4) (AF 18(600)1581)
AD 227704; PB 144015 Unclassified

The observations suggest that the development of a cellular substructure starts as the concentration of the liquid adjacent to the solid interface increases from a value C_0 to C_0/k and the degree of constitutional supercooling increases. This constitutes the incubation range where small projections on the interface grow into elongated cells and finally into regular hexagonal networks. The regularity in the stacking of cells is confined to domains of the order of $1/2$ mm. A stable shape which predominates after the crystal has grown for a considerable distance beyond the incubation range is of the type "a". Combinations of type "a", type "b", and other irregular forms are observed earlier in the growth process, indicating that a preferred growth process establishes a stable cell shape after a period of time. The precise mechanism by which these stable cell shapes develop is not known but appears to be a result of the initial development of elongated cells in a preferred direction and the influence of these anisotropic growth velocities on the distribution of solute in liquid adjacent to the solid. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

MAGNETIC ANALYSIS OF THE PRECIPITATION OF
IRON FROM BETA BRASS, by A. E. Berkowitz and
P. J. Flanders. Interim rept. Aug. 1959, 27p. incl.
illus. diags. tables, refs. (Rept. no. I-A2026-2)
(AFOSR-TN-59-762) (AF 49(638)159) AD 226492;
PB 143830 Unclassified

Also published in Acta Metall., v. 8: 823-832, Dec. 1960.

Single crystals of beta brass containing 0.07 wt % iron were annealed at 300 and 400°C to precipitate the iron. At various stages in the anneals, magnetization curves, hysteresis loops, and torque curves were measured. These magnetic data were analyzed in terms of the concepts of fine particle ferromagnetism to derive size and shape distributions of the iron precipitate particles and the orientations of their crystallographic and shape symmetry axes. In the superparamagnetic size range, the av diam was determined up to 140Å. These particles showed no shape anisotropy and had the same saturation magnetization and magnetocrystalline anisotropy symmetry as bulk iron. The crystal habit of the particles coincided with that of the beta brass matrix. In this size range the particle diam increased at the rate of $t^{2.2}$.

With further annealing single domain properties appeared, and the particles showed increasing elongation in the $\langle 100 \rangle$ directions as determined by analysis of the torque data. Distributions of shapes and sizes of the single domain particles were calculated from remanent torque data. These calculations were consistent with the conclusions from remanence measurements. The shapes of the hysteresis loops and the spread in annealing time between max coercive force and max remanence could be simply interpreted on the basis of mixtures of superparamagnetic, single, and multidomain particles. When the particles were principally in the multidomain ($>300\text{Å}$ diam) range, little information about size distributions could be derived, although the data indicated that the particles become progressively elongated in the $\langle 100 \rangle$ directions. Electron micrographs of replicas gave qualitative confirmation of the conclusions from the magnetic analysis. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

PRECIPITATION IN A BETA-BRASS-Fe ALLOY, by
A. E. Berkowitz and P. J. Flanders. [1959] [2]p. incl.
diagr. (AFOSR-4432) (AF 49(638)159)

Unclassified

Also published in Jour. Appl. Phys., Suppl., v. 30: 1118-1128, Apr. 1959.

Single crystal samples of beta-brass containing 0.1% Fe were annealed at 300°C and 400°C in order to develop the Fe precipitate particles. At intervals during the anneals, magnetic data were obtained and analyzed in terms of the size, shape, orientation, and general magnetic behavior of the precipitate particles. During the earliest annealing stages, superparamagnetic behavior was observed, and particle diam were calculated from the Langevin relation. On continued annealing the magnetic properties indicated the presence of mixtures of superparamagnetic and single domain particles, and subsequently mixtures of single domain and multidomain particles. Torque curves showed that the particles were single crystals, with Fe-like magnetocrystalline anisotropy, oriented with the same crystal habit as the matrix. Single domain behavior was first observed when the particle diam were of the order of 200Å. Elongation of the particles in the $\langle 111 \rangle$ directions and rotational hysteresis were noted when single domain behavior appeared. The magnetocrystalline anisotropy coefficients calculated from the torque data were reasonably close to those of Fe. Maximum remanence was reached before max coercive force due to the much larger initial susceptibility of the superparamagnetic as compared to the multidomain particles. This was confirmed by the shapes of the hysteresis loops for the various cases. (Contractor's abstract)

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Franklin Inst. [Labs. for Research and Development]
Philadelphia, Pa.

ANISOTROPY FIELD, ANISOTROPY TORQUE, AND
THEIR GENERAL ANALYTICAL EXPRESSIONS (Ab-
stract), by H. Amar. [1959] [1]p. [AF 49(638)159]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
177, Mar. 30, 1959.

A description of magnetocrystalline anisotropy by an equivalent field has been used by Kittel and Bickford and later by other investigators in the analysis of ferromagnetic resonance experiments. Kittel and Bickford calculated approximate expressions for the anisotropy field for several special cases. A discussion of the concept of equivalent field is here followed by a general and rigorous derivation. Let e_r (direction cosines $\alpha_1, \alpha_2, \alpha_3$) be a unit vector parallel to the magnetization density I of a ferromagnetic crystal. It is shown in general that a P.E. $U(\alpha_1, \alpha_2, \alpha_3)$ is equivalent to a uniquely defined torque $T = \text{curl } U = \text{grad } U \times e_r$ acting on e_r , $\alpha_1, \alpha_2, \alpha_3$ being the differentiation variables. This leads to an anisotropy field $H' = -\text{grad } U + \lambda I$ where the arbitrary scalar function $\lambda(\alpha_1, \alpha_2, \alpha_3)$ may be so chosen as to make the vectors I, H', T mutually perpendicular. Besides their relevance to the analysis of ferromagnetic resonance experiments, these results may be applied to the calculation of the magnetization curve of single domain uniaxial or cubic crystals.

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

DISLOCATIONS IN DEFORMED SINGLE CRYSTALS OF
ALPHA BRASS. PART I. GENERAL OBSERVATIONS,
by J. D. Meakin and H. G. F. Wilsdorf. Interim rept.
Dec. 1959, 26p. incl. illus. diagrs. refs. (Rept. no. I-A2027-1) (AFOSR-TN-59-1047) (AF 49(638)162)
AD 229609; PB 144570 Unclassified

Also published in Trans. Metall. Soc. AIME, v. 218:
737-745, Aug. 1960.

Using a combined decoration and etching technique the dislocation structure of annealed and deformed α brass has been studied. Annealed crystals revealed a low density forest and well-developed subboundaries; lightly deformed crystals contained discrete groups of dislocations. The dislocation density and the number of dislocations in a group were obtained from the micrographs. Using slip-line data, the mean path of a dislo-

cation and the configuration of groups along an active slip plane have been deduced. Observations on secondary and cross-slip are reported. (Contractor's abstract)

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Franklin Inst. [Labs. for Research and Development]
Philadelphia, Pa.

DISLOCATION GROUPS AND PILE-UPS IN LIGHTLY
DEFORMED α -BRASS (Abstract), by H. G. F. Wilsdorf
and J. D. Meakin. [1959] [1]p. [AF 49(638)162]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
170, Mar. 30, 1959.

Dislocation patterns in α -brass, as revealed by a decoration technique, exhibit the presence of discrete dislocation groups. If these groups are lying not too close to other dislocations, the spacings between dislocations are as predicted by theory. Pile-ups in heavily deformed regions show deviations from the spacings which had been expected theoretically, indicating the strong influence of neighboring groups. In addition, there is direct experimental information on the dislocation density before and after plastic deformation, the number of dislocations per group and the density of the groups. Making use of slip-line data, the average glide length of a dislocation, the average distance between groups on a single slip line, and the number of groups per line have been calculated. Possible mechanisms of dislocation pinning will be discussed.

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Franklin Inst. [Labs. for Research and Development]
Philadelphia, Pa.

STUDY OF THE DISLOCATION DISTRIBUTION IN
SINGLE CRYSTALS OF α BRASS (Abstract), by J. D.
Meakin and H. G. F. Wilsdorf. [1959] [1]p. [AF 49-
(638)162] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
170, Mar. 30, 1959.

A decoration technique capable of revealing individual dislocations in α brass has been used to study the dislocation distribution in the easy-glide range. Doped single crystals strained in tension and aged at 200°C were electro-polished and etched in a phosphoric acid solution, the dislocations being then revealed as small, crystallographic etch pits. The minimum resolvable distance between dislocations is limited by the size of

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the pits and is generally of the order of 500A. The method has been used to study dislocations within the bulk of the crystal by careful sectioning and polishing after the aging treatment. In addition to the expected glide on the primary system, there is clear evidence of slip on secondary systems although all crystals were oriented for single slip. The observations furnish direction evidence of the difficulty experienced by dislocations in cutting through intersection systems, and these results will be discussed in the light of current theories of work hardening.

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

THE INFLUENCE OF THE MOLECULAR MEAN FREE PATH ON THE PERFORMANCE OF HYDRODYNAMIC GAS LUBRICATED BEARINGS, by A. Burgdorfer. Interim rept. June 1958 [17]p. incl. diagrs. (Rept. no. I-A2049-2) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200) **Unclassified**

A modified Reynolds equation is derived for gas-lubricated hydrodynamic bearings operating under "slip flow" conditions. Closed analytical solutions are given for a Rayleigh-type step-bearing and an inclined plane slider bearing for the case of two-dimensional flow. The influence of the molecular mean free path on the performance of bearings of arbitrary form is obtained by means of a small parameter, perturbation technique. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

A STUDY OF THE STABILITY OF EXTERNALLY PRESSURIZED GAS BEARINGS, by L. Licht and H. [G.] Elrod. Interim rept. Nov. 1958, 41p. incl. diagrs. tables. (Rept. no. I-A2049-4) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200) **Unclassified**

The stability of externally pressurized gas bearings is discussed. The pertinent equations are linearized and the stability criteria stated in considering small deviations from the equilibrium point. The flow in the bearing clearance is treated on a distributed rather than on a lumped parameter basis. Results thus obtained, when compared with those previously arrived at by means of a simplified analysis, show a marked divergence in the limiting values of parameters which influence the stability of the bearing. Differences in predictions of the simplified and present analyses with regard to the permissible compression volume in the bearing interspace and the effect of varying the mass of the bearing are emphasized and discussed. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

A DERIVATION OF THE BASIC EQUATIONS FOR HYDRODYNAMIC LUBRICATION WITH A FLUID HAVING CONSTANT PROPERTIES, by H. G. Firod. Interim rept. Apr. 1959, 21p. incl. diagr. (Rept. no. I-A2049-5) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200) **Unclassified**

Small parameter techniques are used to derive Reynolds lubrication equations from the full Navier-Stokes equation for fluids having constant properties. The derivation given applies directly to the geometries of both journal and slipper bearings. It is expected that analytical techniques similar to those employed in this study can be adapted to the development of equations applicable to fluids having pressure and temperature-dependent properties, such as gases.

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

A BIBLIOGRAPHY ON GAS LUBRICATED BEARINGS - REVISED, by E. B. Sciulli. Interim rept. Sept. 15, 1959, 104p. (Rept. no. I-A2049-6) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200) **Unclassified**

Also published in Proc. First Internat'l. Symposium on Gas-Lubricated Bearings, Washington, D. C. (Oct. 26-28, 1959), Washington, Office of Naval Research, p. 533-616.

This work is a revision and expansion of a bibliography issued in December 1957 (item no. FRA.08:001, Vol. II). The present compilation contains 290 applicable references, more than twice the number of its predecessor. Wherever possible a resumé in English of each reference is included. In most cases the abstracts were taken verbatim from the author, translations or revisions being made when necessary. Five indexes are provided. The yearly and corporate name indexes are the same as in the previous bibliography with the exception of new references. The new subject index contains 13 descriptively worded categories or headings specifically chosen to cover the many varieties and types of gas lubricated bearings. Of the other 2 indexes, 1 lists all the patents in numerical order and the other lists the country of origin of the reference when that country is other than the United States. Every effort has been made to make this a comprehensive listing of all references published prior to July 1, 1959 which deal directly or indirectly with gas lubricated bearings.

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

AXIAL, RELATIVE MOTION OF A CIRCULAR STEP BEARING, by L. Licht. Interim rept. Oct. 1959 [9]p. incl. diagrs. (Rept. no. I-A2049-7) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200) AD 231065
Unclassified

Also published in Jour. Basic Eng., v. 81: 109-117, June 1959.

Equations relating the flow of the lubricant and the axial motion of an externally pressurized thrust bearing are developed. The bearing is shown to be stable when the fluid is incompressible. Expressions for local stiffness and damping coefficients, useful in the evaluation of the dynamic response of the bearing, are given. An analog computer solution of the equation of motion is compared with the results of the corresponding, small displacement equation. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

STABILITY OF EXTERNALLY PRESSURIZED GAS JOURNAL BEARINGS, by L. Licht. Interim rept. Oct. 1959 [31]p. incl. diagrs. (Rept. no. I-A2049-8) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200) AD 228299
Unclassified

A stability analysis is developed for gas journal bearings having externally pressurized pads, symmetrically spaced along the circumference. Simplifying assumptions are made and equations of flow and motion are stated in terms of perturbation quantities. The case considered is when the journal, initially in an eccentric equilibrium position, begins to move in an arbitrary direction under the influences of a small, random disturbance. Methods of factorizing and simplifying the characteristic determinants are shown, with the objective of reducing the work of examining the roots of characteristic equations. Special cases, such as the bidirectional thrust bearing and that of the journal initially in concentric position are discussed. Numerical and semi-experimental procedures of determining the coefficients of characteristic equations are outlined. Stability tests are suggested. A simple numerical example is included. Bearing parameters affecting stability are discussed. (Contractor's abstract)

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Franklin Inst. Labs. for Research and Development,
Philadelphia, Pa.

EXTENSION OF THE CONDUCTING SHEET ANALOGY

TO EXTERNALLY PRESSURIZED GAS BEARINGS, by L. Licht. Interim rept. Oct. 1959 [11]p. incl. diagrs. (Rept. no. I-A2049-9) ([Sponsored jointly by Air Force Office of Scientific Research] and Office of Naval Research under Nonr-234200) AD 231065
Unclassified

Incompressible, viscous flow in narrow passages bounded by parallel surfaces yields the 2-dimensional

Laplace equation, $\nabla^2 P = 0$. The pressure field, load capacity and lubricant flow of hydrostatic oil bearings can be readily determined by means of the electric analogy of the conducting sheet. The equation

$$\frac{\partial}{\partial x} \left(P \frac{\partial P}{\partial x} \right) + \frac{\partial}{\partial y} \left(P \frac{\partial P}{\partial y} \right) = 0 \text{ characterizes laminar,}$$

isothermal flow of gas lubricants in otherwise geometrically identical bearings. It is shown that by means of suitable change of the dependent variable the above equation can be reduced to the Laplacian form. The ensuing advantage is the extension of the conducting sheet analogy to externally pressurized thrust and journal guide bearings when the lubricant is a gas. (Contractor's abstract)

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Free U. of Brussels (Belgium).

IRREVERSIBLE PROCESSES IN GASES. I. THE DIAGRAM TECHNIQUE, by I. Prigogine and R. Balescu. [1959] [21]p. incl. diagrs. refs. (AFOSR-TN-59-1237) [AF 61(514)957] AD 229360
Unclassified

Also published in Physica, v. 25: 281-301, Apr. 1959.

A general method is developed of studying the irreversible phenomena in gases consisting of an asymptotic study of the Liouville equation solutions to the limit of a large system ($n \rightarrow \infty$, $\Omega \rightarrow \infty$, N/Ω constant, N being the number of degrees of freedom and Ω the volume of the system). A diagrammatic technique is employed to render the method systematic. It is shown that a limited dependence exist between the topological properties of the diagrams and their asymptotic behavior. The vertices' name and type of connection determine their asymptotic dependence of the volume and name of the particles; their asymptotic dependence is fixed by the structural characteristics of a more global nature. This technique permits analyzing completely the asymptotic behavior of the Liouville equation solution by a simple inspection of the corresponding diagrams.

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Free U. of Brussels (Belgium).

IRREVERSIBLE PROCESSES IN GASES. II. THE EQUATIONS OF EVOLUTION, by I. Prigogine and R. Balescu. [1959] [22]p. incl. diagrs. refs. (AFOSR-TN-59-1238) [AF 61(514)957] AD 229359
Unclassified

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Also published in *Physica*, v. 25: 302-323, Apr. 1959.

The general method developed in a previous paper (Item no. 554) is applied to a number of simple situations. In the case of the weakly coupled homogeneous gas the equations obtained previously are rederived. A systematic deduction of the equations of evolution to their subsequent approximations is shown. The study of inhomogeneous gases leads to a first approximation of Boltzmann's equation. The significance and origin of the irreversibility of the mechanical systems having a large number of degrees of freedom are also discussed.

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STATISTICAL MECHANICS AND THERMODYNAMICS OF IRREVERSIBLE PROCESSES. VOL. I. IRREVERSIBLE PROCESSES IN GASES, by R. Balescu and I. Prigogine. [1959] 190p. incl. diagrs. refs. (Technical rept. no. EOARD-PR-59-18, vol. 1) (AFOSR-TR-59-44a) (AF 61(514)957) AD 214526; PB 140695

Unclassified

The idea of an ensemble Liouville's equation and the concept of weakly-coupled systems are introduced. This is followed by a discussion of the general properties of the distribution functions; precise definitions are collected and their value at thermodynamical equilibrium is discussed. The various contributions are classified; beginning by the association of a diagram to each contribution. This association is chosen in such a way as to establish a one-to-one correspondence between the structure of the diagram and the asymptotic behavior of the contribution which it represents. Also examined is an interesting property of disconnected diagrams. This property enables one to perform easily certain types of summations. The diagram technique is applied to the derivation of irreversible equation for the one particle distribution function on a weakly-coupled perfect homogeneous gas. Finally, applications are made of the equations previously obtained to 2 concrete problems inspired from astronomy; these are: (1) the phenomenon of dynamical friction which is a typical Brownian phenomenon, and (2) a dissipative mechanism, illustrated by the problem of the dissociation of a binary star through its interaction with the medium.

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Free U. of Brussels (Belgium).

STATISTICAL MECHANICS AND THERMODYNAMICS OF IRREVERSIBLE PROCESSES. VOL. II. IRREVERSIBLE PROCESSES IN POLYATOMIC GASES, by A. Festschrift and I. Prigogine. [1959] 44p. (Technical rept. no. EOARD-PR-59-18, vol. 2) (AFOSR-TR-59-44b) (AF 61(514)957) AD 214527; PB 140696

Unclassified

The approach to equilibrium of a gas of polyatomic molecules is described. The case is considered, in a preliminary manner, of a single dipole interacting through electrostatic forces with ions. This example shows clearly the main differences between the approach to equilibrium of the translational and internal degrees of freedom

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Free U. of Brussels (Belgium).

STATISTICAL MECHANICS AND THERMODYNAMICS OF IRREVERSIBLE PROCESSES. VOL. III. QUANTUM MECHANICS OF IRREVERSIBLE PROCESSES, by I. Prigogine, M. Toda, and S. Ono. [1959] [42]p. incl. diagrs. refs. (Technical rept. no. EOARD-PR-59-18, vol. 3) (AFOSR-TR-59-44c) (AF 61(514)957) AD 214528; PB 140697

Unclassified

Quantum systems are discussed, wherein it is shown that the previously developed diagram technique (Item no. 556) may be extended to cover also the case of quantum mechanics. The only difference is the definition of the vertex. In the quantum mechanical case to each vertex there corresponds a finite transfer of momentum, as opposed to the classical case where an infinitesimal transfer exists. This difference directly expresses the indivisibility of quantum act. The case of the quantum gases is first treated, followed by the study of harmonic oscillators, and, finally 2 simple examples are discussed—homogeneous and inhomogeneous weakly-coupled gases.

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Free U. of Brussels (Belgium).

STATISTICAL MECHANICS AND THERMODYNAMICS OF IRREVERSIBLE PROCESSES. VOL. IV. ELECTRODIFFUSION, by W. Kauman and T. [A.] Bak. [1959] 147p. incl. diagrs. table, refs. (Technical rept. no. EOARD-PR-59-18, vol. 4) (AFOSR-TR-59-44d) (AF 61(514)957) AD 214529; PB 140698

Unclassified

Electrodiffusion is presented as a particular case of exchange diffusion which arises through the interaction of a chemical exchange reaction with a flow due to an external force field. The macroscopic transport equations of the electrodiffusion are formulated and solved by Fourier-transforming to give equations of the Hill type or by applying time-dependent perturbation techniques. It is shown that the effective diffusion coefficient in electrodiffusion is the sum of the ordinary diffusion constant and a term proportional to the square of the electric field and containing simple algebraic functions of the ionic mobilities, the rate constants of the chemical reaction, and the frequency of the applied field. Expressions for the ionic concentration are given for time-dependent and time-independent electric fields and for finite and infinite boundary conditions. The stationary electric current in a finite system is calculated, and

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the entropy production of electrodiffusion is derived. The application of electrodiffusion to measurements of the rate constants by diffusional or electrical measurements is discussed. A theoretical investigation was also made of the behavior of amphoteric electrolytes under the combined action of a gradient of pH and an electrostatic potential.

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Free U. of Brussels (Belgium).

ON THE TRANSPORT EQUATION IN QUANTUM GASES, by I. Prigogine and S. Ono. [1959] [8]p. incl. diags. [AF 61(514)957] Unclassified

Published in *Physica*, v. 25: 171-178, Feb. 1959.

It is shown that a general diagram technique developed in a recent paper (item no. 554, Vol. III) for the classical system can be applied without modification to the quantum system. The only difference is the definition of the vertex which corresponds in the quantum case to a finite transfer of momentum. This permits considerable simplification of the calculations. The transport equation for a weakly coupled gas is established. This equation changes character when the characteristic length of the inhomogeneity approaches a value comparable to the de Broglie wave length of the particles.

561

Free U. of Brussels. [Dept. of Chemical Physics] (Belgium).

IRREVERSIBLE PROCESSES IN A PLASMA, by R. Balescu. [1959] 4p. (AFOSR-TN-59-203) (AF 61(052)-179) AD 264280 Unclassified

Also published in *Physica*, v. 25: 324-325, Feb. 1959.

The diagram technique recently developed by Prigogine and Balescu (*Physica*, v. 23: 555, 1957) is applied to a plasma, and some preliminary results are briefly reported.

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Free U. of Brussels. [Dept. of Chemical Physics] (Belgium).

THEORY OF ELECTRODIFFUSION, by T. A. Bak and W. G. Kauman. [1959] [13]p. [AF 61(052)179] Unclassified

Published in *Trans. Faraday Soc.*, v. 55: 1109-1121, July 1959.

A theory of electrodiffusion based on macroscopic transport equations rather than stochastic arguments

is proposed. For a constant applied field the present theory confirms results previously obtained by Mysels, whereas with an alternating field it gives different results. The diffusion equations which arise are Fourier-transformed to give equations of the Hill-type or are solved by time-dependent perturbation techniques leading to essentially the same equations. The possible use of this effect as a method of determining rate constants is discussed. The theory also shows that measurements of the diffusion constant may possibly be replaced by electrical measurements. (Contractor's abstract)

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Free U. of Brussels. [Dept. of Chemical Physics] (Belgium).

IRREVERSIBLE PROCESSES IN A PLASMA: EFFECT OF LONG RANGE FORCES, by R. Balescu. [1959] [4]p. [AF 61(052)179] Unclassified

Published in *Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases*, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 32-35. (AFOSR-TR-60-87)

The well known divergences appearing in the calculation of transport coefficients of a plasma may be eliminated without any need of an arbitrary cut-off if one starts from a transport equation which takes into account correctly the long range of the electrostatic interactions. Such an equation can be derived from first principles by applying the statistical mechanical methods developed by Prigogine and Balescu. The characteristic property of this equation is its collective character. The main consequences of this property are discussed.

564

Free U. of Brussels. Lab. of Molecular Chemistry and Physics (Belgium).

VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURE, by P. Goldfinger, M. Ackerman, and M. Jeunehomme. Final technical rept. Jan. 1959, 59p. incl. diags. tables, refs. (AFOSR-TR-59-32) (AF 61(052)19) AD 212930; PB 142100 Unclassified

The vaporization of ZnS, CdS, HgS, CdSe, HgSe, CdTe, HgTe from 400 to 1175°K, of sulfur, selenium, tellurium from 350 to 600°K, InAs, GaP, GaSb from 900 to 1250°K and of an iron-nickel alloy from 1400 to 1600°K have been investigated. The molecular composition of the vapor in equilibrium with the solid compounds (except for GaSb which in part of the experiments is liquid) has been determined. No molecules containing both elements of the compounds are present in the vapor phase at a measurable concentration (10^{-3} or less). The change in free energy, heat content and entropy for the vaporization processes have been measured and permit

AIR FORCE SCIENTIFIC RESEARCH

the calculation of thermodynamic properties of the compounds investigated. The vapors contain the group V and group VI elements in the form of different polyatomic species; equilibria between these species have been observed and the relevant thermodynamic quantities measured: $D(\text{Fe}_2) = 49 \pm 2 \text{ kcal}$; $D(\text{As}_2 - \text{As}_2) = 65 \pm 2 \text{ kcal}$; $D(\text{Sb}_2 - \text{Sb}_2) = 62 \pm 1 \text{ kcal}$; $D(\text{S}_2 - \text{S}_2 - \text{S}_2) = 61 \pm 7 \text{ kcal}$; $S_{530}^\circ(\text{S}_8) = 100 \pm 8 \text{ e.u.}$ Preliminary experiments on the evaporation of an alloy show that this method can give useful information on thermodynamic properties, especially on activities of the components. (Contractor's abstract)

565

Fribourg U. Dept. of Physics (Switzerland).

LIQUIDS FOR USE IN LARGE BUBBLE CHAMBERS, by B. Hahn, G. Riepe, and A. W. Knudsen. [1959] [9]p. incl. diagrs. table. (AFOSR-TN-59-561) (AF 61(514)-1262) AD 253122 Unclassified

Also published in Rev. Scient. Instr., v. 30: 654-655, Aug. 1959.

The pure liquids C_3F_8 , C_4F_{10} , SF_6 , C_2ClF_5 , CBrF_3 and TeF_6 , as well as binary mixtures of these sub-

stances, have been found to have very desirable properties for use in large bubble chambers for studying decay modes of elementary particles. (Contractor's abstract)

566

Fribourg U. [Dept. of Physics] (Switzerland).

STABILIZATION AND CONTROL OF BUBBLE CHAMBER SENSITIVITY, by B. Hahn and A. W. Knudsen. [1959] [2]p. incl. diagrs. [AF 61(514)1262]

Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 506-507.

The bubble density of a bubble track is known to depend strongly on the liquid temperature and on the pressure drop. Pressure stabilization by providing pressure communication of the chamber liquid with a reference pressure through flexible membranes is discussed.

Frick Chemical Lab., Princeton, N. J.
see Princeton U. Frick Chemical Lab., N. J.



AIR FORCE SCIENTIFIC RESEARCH

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Gaustad Mental Hospital, Oslo (Norway).

AIRBORNE EEG RECORDING IN HIGH PERFORMANCE AIRCRAFT, by C. W. Sem-Jacobsen, O. Nilseng and others. Final technical rept. Jan. 28, 1959, 4p. (AFOSR-TR-59-35) (AF 61(514)1201) AD 213036; PB 145074 Unclassified

Thirty pilots performed 10 commonly flown maneuvers during which EEG recordings were made to determine whether the EEG was a suitable device for measuring physiological and psychological responses to flight stresses. The pilots were divided into 3 groups on the basis of the EEG records. Group A showed only minimal changes in response to the test flight. Group B showed marked high voltage changes of short duration in response to the same maneuvers. In the EEG's of the pilots belonging to group C gross changes of probably more pathological nature were seen. Out of the 30 pilots, 19 were in group A; 8 were in group B, and 3 in Group C. After the test the pilots in group A appeared unaffected by the flight, kept good radio contact, were in good spirits, and reported no blackouts. The pilots of the B-group, on returning to the ground, perspired and appeared fatigued. They revealed blackouts and made mistakes in recollecting the flight. The pilots of group C were pale, perspired heavily, and had gone through episodes of loss of consciousness.

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Gaustad Mental Hospital, Oslo (Norway).

ELECTROENCEPHALOGRAPHIC STUDY OF PILOT STRESSES IN FLIGHT, by C. W. Sem-Jacobsen. [Final rept.] [1959] [5]p. incl. diagrs. table. (AFOSR-1727) (Sponsored jointly by Air Force of Scientific Research under [AF 61(052)197], Ford Foundation, and Norwegian Air Force) Unclassified

Presented at Thirtieth annual meeting of the Aero Med. Assoc., Los Angeles, Apr. 29, 1959.

Also published in Aerospace Med., v. 30: 797-801, Nov. 1959.

With 8-channel airborne EEG equipment, tracings were made of a group of jet pilots, as well as personnel with no previous flight experience, during simulated combat flight. A uniform standardized flight schedule was utilized. On the basis of the EEG tracings, 30 jet pilots were divided into 3 groups according to the changes seen in the records. A minimal, B marked, and C gross. The same pilots were graded by the Air Force according to their flight performances. The results obtained strongly support a close correlation between the changes in the brain as measured by EEG during flight stress and the pilot's ability to perform under these conditions. Airborne EEG recording is demonstrated as a new method for studying the stress to which the jet fighter pilot is subjected. (Contractor's abstract)

569

General Applied Science Labs., Inc., Westbury, N. Y.

THE OSCILLATION AND NOISE OF AN OVERPRESSURE SONIC JET, by A. G. Hammitt. Nov. 1959, 35p. incl. illur. diagrs. (GASL Technical rept. no. 137) (AFOSR-TN-59-1307) (AF 49(638)194) AD 233878; PB 146364 Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 673-680, Sept. 1961.

A series of experiments on plane 2-dimensional and axially symmetric over pressure sonic jets were performed to study the oscillating behavior of the jet and accompanying sound field. Shadowgraphs were obtained which show the oscillations and generation of the sound waves for the plane 2-dimensional jet in some detail; but similar results could not be obtained for the axially symmetric jet. Measurements from these pictures show that the oscillating jet and sound fields can be described in terms of the length of the shock wave cells. The importance of the sound waves acting upon the base of the jet is demonstrated and it is found that the jet can be stabilized by shielding its base from these sound waves. (Contractor's abstract)

570

General Applied Science Labs., Inc., Westbury, N. Y.

ON THE AERODYNAMIC NOISE OF A JET, by S.-I. Cheng. Apr. 1959, 56p. incl. diagrs. (GASL Technical rept. no. 148) (AFOSR-TN-59-1308) (AF 49(638)194) AD 233164; PB 148689 Unclassified

Also published in Jour. Aero/Space Sci., v. 28: 321-331, Apr. 1961.

A new model is advanced for analyzing the broad spectrum noise of a turbulent jet. To the sound emitting small scale turbulent eddies (with frequencies much larger than those large scale ones, responsible for the intermittent phenomena near the edge of a turbulent jet), the shear layer is laminar and is of an irregular contour, as if the large scale turbulent motions were frozen. The linearized analysis is then applied to the laminar shear layer to relate the acoustic oscillations across it. The concept of "geometrical acoustics" is generalized to represent the passage of an acoustic ray through a laminar shear layer. The "generation" of the acoustic ray is visualized as the schematic representation, within the framework of geometrical acoustics, of the action of the Reynolds stress in transferring energy from the shearing mean flow to the acoustic waves. Such action of the Reynolds stress is of crucial importance to the aerodynamic noise of high speed turbulent jet where the Reynolds stress is the fundamental element of the radiating quadrupoles according to Lighthill. In relating the quadrupole strength across the shear layer, those acoustic waves that become "stationary" with

AIR FORCE SCIENTIFIC RESEARCH

respect to the local mean flow somewhere in the interior of the shear layer, are significantly modified by the viscous action through the critical layer. (Contractor's abstract)

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General Applied Science Labs., Inc., Westbury, N. Y.

NOTE ON THE BROAD SPECTRUM NOISE OF A JET AND ITS SILENCER, by S.-I. Cheng. Nov. 1959, 23p. incl. diagrs. (GASL Technical rept. no. 149) (AFOSR-TN-59-1309) (AF 49(638)194) AD 236522; PB 147320
Unclassified

Some of the implications are amplified of the model for analyzing the broad spectrum noise of a jet as was presented previously (item no. 570) when applied to practical systems. Experimental results on the noise reduction by the C. F. 100 Orenda IIR diffuser silencer and by the UTIA Model Ground Muffler are discussed from the points of view of both the Lighthill's model and the present model. Based upon Lighthill's model, it appears necessary to assume a very large increase of the turbulence intensity accompanying the diffusion of the jet velocity. According to the present model, where the change of the turbulence intensity is neglected, the observed noise reduction or increase is explained by the change of the relative thickness of the shear layer that appears to be of reasonable magnitudes. (Contractor's abstract)

572

General Applied Science Labs., Inc., Westbury, N. Y.

THE NOISE FIELD OF A SUBSONIC JET, by G. Moretti and S. Slutsky. Nov. 1959, 165p. incl. diagrs. table. (GASL Technical rept. no. 150) (AFOSR-TN-59-1310) (AF 49(638)194) AD 236386; PB 147321
Unclassified

The acoustic far field of a singularity was investigated under several different conditions of the medium. The simple cases of a source in an infinite wind, as observed at a fixed or a moving point, were analyzed to permit comparison with physical systems of practical interest, e.g., jet engine fly-by noise analysis. Widespread misunderstanding of the Lighthill Mach number dependence was noted and clarified by means of the above analysis. The far field of a singularity imbedded in a jet was determined as a function of jet velocity and temperature distribution with special emphasis on the case of uniform distribution in the jet. Comparison of experimental results is made and fair agreement noted. Factors involved in failure to obtain complete agreement are discussed. (Contractor's abstract)

573

General Dynamics Corp. Convair Div., Pomona, Calif.

THERMAL STRESSES IN A SQUARE PLATE WITH A CENTRAL CIRCULAR HOLE SUBJECTED TO AN ARBITRARY TEMPERATURE GRADIENT, by R. D. Sutherland and F. M. White. Feb. 1959, 33p. incl. diagrs. tables. (Rept. no. TM-349-2) (AFOSR-TR-59-11) (AF 49(638)235) AD 209850; PB 139663
Unclassified

An analysis of the thermal stress problem in a thin square plate containing a single concentric circular perforation is presented for an arbitrary temperature distribution. The results of the analysis are applied to a plate subjected to a simple doubly-symmetrical temperature distribution. The hoop stresses are calculated around the perimeter of the perforation and are presented as functions of angular displacement for 4 different inside radii. (Contractor's abstract)

574

General Dynamics Corp. Convair Div., Pomona, Calif.

THERMO-ELASTIC EQUATIONS APPLICABLE TO THICK-WALL POINTED SHELLS OF REVOLUTION, by R. D. Sutherland and R. G. Shook. Nov. 1959, 29p. incl. diagr. (Rept. no. TM-349-14) (AFOSR-TN-59-1274) (AF 49(638)592) AD 233495; PB 146439
Unclassified

The thermo-elastic equations necessary to define the stress distribution in a thick-wall, pointed shell of revolution are presented. A coordinate system based on the classic ogive shape which is applicable to a variety of low aerodynamic drag shapes is utilized in the analysis. Stress functions equations are derived in these ogive coordinates. Techniques are presented for use at the boundaries of the shells of revolution and at the axis of revolution. The equations presented can be solved by numerical methods and are a basis for further work in obtaining analytical solutions to the stresses in thick-wall, pointed shell of revolution. (Contractor's abstract)

575

General Dynamics Corp. General Atomic Div., San Diego, Calif.

FORMATION OF FREE-RADICAL SOLIDS USING ATOMIC-BEAM TECHNIQUES, PART I. MEASUREMENT OF VAPOR PRESSURE OF HYDROGEN AT TEMPERATURES BETWEEN 3° AND 10°K, PART II, by W. L. Fite and G. L. Guthrie. July 1959, 51p. incl. illus. diagrs. refs. (Rept. no. GA-803) (AFOSR-TN-59-364) (AF 49(638)301) AD 213674; PB 142972
Unclassified

Part I presented at Symposium on Unstable Chem. Species, Los Angeles, Calif., June 23-24, 1958.

AIR FORCE SCIENTIFIC RESEARCH

Part I: The probability of condensation and stabilization of atomic H in matrices of solid molecular H and

Ar appears to be less than 10^{-5} under the conditions of atomic-beam experimentation, including the use of spin-aligned atoms. From energy-storage studies of molecular H, there appear to be 2 states of solid H formed from condensation of molecular H, and that state which is formed seems to depend on whether the condensation occurs above or below about 4.0°K. Further understanding of the formation of atomic-H solids depends very strongly on the obtaining of more information on solid molecular H, in particular the rates for phase transition between the solid and gaseous states. Part II: The experimental method chosen made use of the fact that, at the temperatures of interest, the density of H is low and the mean free path is very large compared with the diameter of the tubing in the apparatus. Since under these circumstances the pressure and temperatures in 2 different parts of the apparatus are quantitatively related, the H pressure at the coldest part of the apparatus could be calculated if the coldest temperature was known. Measurements of the vapor pressure of H were made at temperatures in the liquid-He range and slightly above. The measured pressure after correction appeared to be of the same order of magnitude as would be given by an extension of the Wooley, Scott, and Brickwedde formula (Jour. Research Nat'l. Bur. Standards, v. 41: 379, 1951).

576

General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

IONIZATION OF ATOMIC OXYGEN ON ELECTRON IMPACT, by W. L. Fite and R. T. Brackmann. Oct. 8, 1958 [4]p. incl. diagr. (Rept. no. GA-544) (AFOSR-TN-59-17) (AF 49(638)356) AD 208598 Unclassified

Also published in Phys. Rev., v. 113: 815-816, Feb. 1, 1959.

The cross section for ionization of atomic oxygen has been measured by using modulated atomic beam techniques. First the ratio of the cross sections for production of the molecular oxygen ion and for total ion production in collisions of electrons with oxygen molecules was measured. Then the ratio of the ionization cross section of the free oxygen atom and the cross section for production of the molecular ion in electron-molecule collisions was determined. From the previously known total ionization cross section of the molecule, and the measured ratios, the unknown cross sections were determined. The experimental results are compared with the calculations of Seaton. (Contractor's abstract)

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General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

IONIZATION OF ATOMIC AND MOLECULAR OXYGEN ON ELECTRON IMPACT, by W. L. Fite and R. T. Brackmann. Mar. 1959, 16p. incl. diagrs. refs. (Rept. no. GA-632) (AFOSR-TN-59-18) (AF 49(638)356) AD 208599; PB 139995 Unclassified

In order to determine absolute cross sections of atomic and molecular oxygen on electron impact, ratios of cross sections for different ionization processes were measured directly, using the atomic-beam apparatus, and then compared with the absolute cross-section measurements of other investigators. In particular, it is quite straightforward to measure the ratio Q_1/Q_2 , where Q_1 is the ionization cross section of the atom, i.e., the cross section for the process $e + O \rightarrow O^+ + 2e$, and Q_2 is the cross section for the process $e + O_2 \rightarrow O_2^+ + 2e$. In a second experiment the ratio Q_2/Q_T was determined, where Q_T is the total cross section of the oxygen molecule for producing ions, irrespective of the mass, charge, and initial kinetic energy of the resultant ions. (Contractor's abstract)

578

General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

THE USE OF MODULATED ATOMIC-BEAM TECHNIQUES FOR THE STUDY OF SPACE-FLIGHT PROBLEMS, by G. S. Hollister, R. T. Brackmann, and W. L. Fite. Oct. 14, 1959 [19]p. incl. diagrs. (Rept. no. GA-1024) (AFOSR-TN-59-1033) (AF 49(638)356) AD 229282; PB 150065 Unclassified

Presented at Conf. on Phys. Chem. in Aerodynam. and Space Flight, Pennsylvania U., Philadelphia, Sept. 1-3, 1959.

Also published in Planetary and Space Sci., v. 3: 162-168, Feb. 1961.

Two types of experiments are discussed. In the first, an incident beam impinges on a surface and the particles leaving the surface are examined with a mass spectrometer. By varying the incident beam and/or surface temperature, thermal accommodation coefficients are determined for a variety of surfaces and gases. Using an incident atomic beam, the probability that an atom will rebound from the surface as a free atom is measured; from examination of the reflected molecular signal, information on the probability of reassociation at the surface is obtained. In the second, the atomic beam, which is monitored mass-spectrometrically, is allowed to strike a surface placed on a torsion balance, and momentum transfer is measured directly. In these

AIR FORCE SCIENTIFIC RESEARCH

experiments, the atomic-beam apparatus is used as an atomic wind tunnel; when a hydrogen-atom beam from a furnace source operating at 3000°K is used, the case of a high-altitude satellite is fairly closely duplicated. Results of a number of experiments using these techniques are presented. (Contractor's abstract)

579

General Dynamics Corp. General Atomic Div.,
San Diego, Calif.

IONIZATION OF HYDROGEN AND OXYGEN ATOMS
NEAR THRESHOLD (Abstract), by W. L. Fite and R.
T. Brackmann. [1958] [1]p. [AF 49(638)356]

Unclassified

Presented at Eleventh Annual Gaseous Electronics
Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
170, Mar. 6, 1959.

Using modulated atomic beam techniques, the cross
sections for ionization of ground-state hydrogen and
oxygen atoms upon electron impact have been measured,
in the neighborhood of threshold. For both atoms the
cross section appears proportional to the excess inci-
dent electron energy, and confirms the prediction of
Geltman. For the hydrogen atom the absolute value of
the cross-section slope is $0.078 (\pm 0.006) \pi a_0^2/\text{ev}$,
while Geltmann's S-wave theory predicts $0.044 \pi a_0^2/\text{ev}$.

The discrepancy is understood on the basis of the the-
ory's consideration of only the S-wave contributions to
the total cross section.

580

General Electric Co. [Flight Propulsion Lab. Dept.]
Cincinnati, Ohio.

NITROGEN AT HIGH TEMPERATURES, by F. Martinek.
Feb. 1959, 1v. incl. diagrs. tables, refs. (AFOSR-TN-
59-264) (AF 49(638)243) AD 212467

Unclassified

Presented at ASME Symposium on Thermophysical
Properties, Purdue U., Lafayette, Ind., Feb. 23-26,
1959.

The basic thermodynamic properties of pure nitrogen
at high temperatures are presented. Internal energy,
enthalpy, entropy, electron density, and electrical con-
ductivity are given in engineering units for the tempera-
ture range from 5000 to 30,000°K, and pressure varying
from 0.2 to 100 atm. The temperature and pressure
dependency of dissociation and ionization is also shown.
All calculations are based on statistical thermodynam-
ics. (Contractor's abstract)

581

General Electric Co. Flight Propulsion Lab. Dept.,
Cincinnati, Ohio.

HIGH TEMPERATURE HEAT TRANSFER FROM
GASES TO CYLINDERS AND NOZZLES, by L. E. Kanter,
F. Martinek, and M. L. Ghai. Feb. 1, 1958-Feb. 1, 1959,
128p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-
488) (AF 49(638)243) AD 215841; PB 143597

Unclassified

A gas stabilized plasma generator operating with
nitrogen gas and water cooled metal electrodes was
successfully operated to supply the hot gas necessary
for this study. The required instrumentation was, or is
being, developed to measure the various temperatures,
flow velocities, and power consumption rates experi-
enced with the generator and associated equipment. Pre-
liminary temperature traverses and photographic studies
were made to investigate the flow field of the effluent
gas. Calculations are presented for the thermodynamic
properties of nitrogen gas at high temperatures including
the pressure effect. Also included are the general con-
siderations on experimentation and data reduction as
pertains to this study. (Contractor's abstract)

582

General Electric Co. General Electric Research Lab.,
Schenectady, N. Y.

PROCEEDINGS OF INTERNATIONAL CONFERENCE
ON STRUCTURE AND PROPERTIES OF THIN FILMS,
BOLTON LANDING, N. Y. (Sept. 9-11, 1959), ed. by
C. A. Neugebauer, J. B. Newkirk, and D. A. Vermilyea.
New York, Wiley and Sons, 1959, 561p. incl. illus. diagrs.
tables, refs. (AFOSR-TR-59-212) [AF 49(638)605]

Unclassified

This conference brought together investigators con-
cerned with the phase transformations, chemical reac-
tivity, superconductivity, electric resistance, Hall effect,
magnetic properties, and magnetoresistance related to
thin films. Papers were also presented on the little
known physical status of films that are responsible for
their anomalous properties and on problems of growth
and characterization. Surface chemistry was also dis-
cussed shedding light on structures and interactions at
surfaces. Also included were papers of a strictly theo-
retical nature.

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[Georgetown U., Washington, D. C.].

CHANGES IN PALMYRA ATOLL AND ITS VEGETA-
TION THROUGH THE ACTIVITIES OF MAN, 1913-1958,
by E. Y. Dawson. [1959] 51p. incl. illus. diagrs. refs.
(AFOSR-TN-59-141) (Sponsored jointly by Air Force
Office of Scientific Research under AF 49(638)187 and
National Institutes of Health) AD 210972

Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in Pacific Naturalist, v. 1: 1-51, Feb. 4, 1959.

This history of man-made changes in this atoll is given and illustrated. The past and present land vegetation is described, and collections of 38 naturalized species cited. A survey of the marine vegetation is given and contrasted to known conditions 45 yr ago; 89 species are cited of which Pterocladia tropica, Cryptonemia? umbraticcia, Antithamnion palmyrense, and Alsidium? pacificum are described as new. It is concluded that ecological conditions throughout a large part of the feeding area of fishes on the reef-flats and in the lagoons have been changed by man's activities to favor the development of Lyngbya majuscula which is now ubiquitous. Certain past tests and occurrences which indicate that this alga may have properties toxic to human beings place it under strong suspicion as a contributor to ichthyosar-cotoxism in the Palmyra region.

584

[Georgetown U., Washington, D. C.]

SCIENCE AND SOCIAL CHANGE, by N. F. Washburne. Aug. 17, 1959, 44p. incl. diagrs. tables, refs. (AFOSR-TN-59-910) [AF 49(638)187] AD 227172

Unclassified

The problem of assessing the relationships between science and social change is discussed. A model is presented in which social change is conceived of as a series of waves, each wave beginning with some overwhelming event or process which strikes at the functions of one or more of our social systems, necessitating structural changes therein. Six types of such agents of change are noted: technological developments, population movements, changes in natural resources, natural occurrences, physiological changes and world pressures. These affect first those areas of our social structure which we hold least sacred, but as the structural alterations made necessary by them are put into effect, dysfunctions arise in other parts of our social structure, necessitating further alterations, and so on, as our whole society adjusts to maintain equilibrium. Trends in 4 of the agents of change are traced, and their relationship to science is discussed. It is concluded that while there will be great growth in American science in the future, scientists will nonetheless remain in short supply. (Contractor's abstract)

585

Georgetown U., Washington, D. C.

AUTOMATIC TEACHING; THE STATE OF THE ART [A CONFERENCE], Pennsylvania U., Philadelphia (Dec. 8-9, 1958), ed. by E. Galanter. New York, Wiley and Sons, 1959, 198p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-157) (AF 49(638)187) AD 225911

Unclassified

The techniques of teaching by machines are discussed in the 16 papers presented by some of the leading researchers in the behavior sciences. Programming, efficient learning, programs in elementary subjects, psychology, elements of successful programs, and the relation between programmed textbooks and teaching machines are presented.

586

Georgetown U. Medical Center, Washington, D. C.

SCORING MANUAL FOR A SENTENCE COMPLETION TEST OF HOSTILITY, AGGRESSION ANXIETY AND PROJECTION, by H. Zimmer. Sept. 1959, 1v. (AFOSR-TN-59-949) (AF 49(638)487) AD 227059

Unclassified

This test was developed as a research tool for the purpose of studying intrapersonal processes through the medium of hostility. It was constructed because it appeared that a similar instrument was not available. The measurement of 3 processes is attempted by means of the test: (a) the subject's direction and strength of hostility, (b) the extent of his aggression anxiety, and (c) his proclivity for projecting hostility. Nine items are devoted to the measurement of aggression anxiety, 12 to projection of hostility, and the remaining 34 to measuring hostility per se. The last 34 items are divided into 3 categories, on the basis of the stimulus value of their sentence stems: 12 are labelled "aggressing against," 7 are "ambipulative," and 15 are called "being agressed against." Together they constitute the hostility group, and are scored and treated in an identical fashion. (Contractor's abstract)

Giannini Research Lab., Santa Ana, Calif.

see Plasmadyne Corp. Giannini Research Lab., Santa Ana, Calif.

587

Göttingen U. Inst. of Physiology (Germany).

THE INTERACTION OF TWO TYPES OF INSPIRATORY NEURONS IN THE REGION OF THE TRACTUS SOLITARIUS OF THE CAT, by R. von Baumgarten and E. Kanow. [1958] [13]p. incl. diagrs. refs. (AFOSR-TN-59-841) (AF 61(514)1265) AD 225420

Unclassified

Also published in Arch. Ital. Biol., v. 96: 361-373, 1958.

Microelectrode recordings of spike discharges from the lower brainstem of decerebrated or of anaesthetized cats led to the conclusion that a pool of neurons firing during inspiration are localized in a circumscribed reticular region close to the tractus solitarius, 1-3 mm rostrally to the obex. One group of units (R_{α} -neuron) was found to fire synchronously with the phrenic motoneurons during each inspiration. Their discharge was not abolished during the respiratory paralysis produced by succinyl-choline, but was inhibited simultaneously

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AIR FORCE SCIENTIFIC RESEARCH

Hamilton Coll., Ont. (Canada) see McMaster U.
Hamilton Coll., Ont. (Canada).

Hammond Metallurgical Lab., New Haven, Conn. see
Yale U. Hammond Metallurgical Lab., New Haven,
Conn.

588

Harvard U. [Cruft Lab.] Cambridge, Mass.

SOME OBSERVATIONS ON POOL BURNING, by H. W.
Emmons. [1959] [17]p. incl. diagrs. (AFOSR-TN-59-
1084) (AF 49(638)29) Unclassified

Also published in Proc. Internat'l. Symposium on The
Use of Models in Fire Research, Washington, D. C.
(Nov. 9-10, 1959), Washington, Nat'l. Acad. Sci., 1961,
p. 50-57.

The burning of acetone and methyl alcohol from small
open pools was examined for pool sizes from 1/4 in.
to 10 in. The very large influence of the radiant heat-
ing of the surrounding area on convective disturbances
is noted and the subsequent transfer of some of this
heat through the pan rims to the fuel is examined. A
method of separating burning rate into more tractable
pieces is proposed and is shown to be effective in
treating the meager data now available. (Contractor's
abstract)

589

Harvard U. Cruft Lab., Cambridge, Mass.

TRANSIENT PHENOMENA IN SEMICONDUCTOR
DIODES, by Y.-F. Chang. Jan. 5, 1959 [49]p. incl.
diagrs. tables, refs. (Technical rept. no. 294) (Spon-
sored jointly by Air Force Office of Scientific Re-
search, Office of Naval Research, and Signal Corps un-
der Nonr-186616) AD 225451 Unclassified

Transient analyses have all suffered from 2 simplifying
assumptions: the assumption of low-level injection, and
the exclusion of reactive circuit elements. This pres-
ent study concerns the transient analysis of p-n junc-
tions without these restrictions. The problem was
dealt with using approximation methods. The approxi-
mation involved was that of the distribution of injected
holes in the base-region of p-n junction diodes. Com-
parison of results showed very good agreement between
theoretical and experimental transients. Two new re-
lations have been derived from rigorous considerations.
The boundary condition relates the total current flow-
ing through the p-n junction and the normal derivative
of the carrier concentration at the junction. The injec-
tion relation is the relation between the total current
and the injecting hole-current. It was found that the
physical size of the p-n junction base region and the
equilibrium carrier composition within the junction
could be determined from 3 simple electrical transient

measurements. An equivalent circuit of the p-n junc-
tion under transient conditions has been derived from
the consideration of many different transient responses.

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Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR SPIN SATURATION BY ULTRASONICS IN
SODIUM CHLORIDE, by E. F. Taylor and N.
Bloembergen. Jan. 15, 1959 [8]p. incl. diagrs. table,
refs. (Technical rept. no. 284) (Sponsored jointly by
Air Force Office of Scientific Research, Office of Na-
val Research, and Signal Corps under Nonr-186616)
AD 225452 Unclassified

Presented at meeting of the Amer. Phys. Soc., Williams
Coll., Williamstown, Mass., Oct. 11, 1958.

Also published in Phys. Rev., v. 113: 431-438, Jan. 15,
1959.

Abstract also published in Bull. Amer. Phys. Soc., Ser-
ies II, v. 4: 108, Mar. 1, 1959.

An ultrasonic vibrational mode with rather well-defined
properties has been set up in a cylindrical single crys-
tal of sodium chloride. The saturation of the spin lev-
els of Na^{23} and Cl^{35} by acoustically induced quadrupole
transitions, $\Delta m = \pm 2$, has been measured in the steady
state by a standard nuclear magnetic resonance tech-
nique, for several orientations of the ultrasonic wave
and external magnetic fields. The components of the
fourth-order tensor connecting the electrical field gra-
dient tensor at the nuclei with the strain deformation
tensor have been determined. The components satisfy
an isotropy condition rather than the Cauchy relation.
The results show the inadequacy of the ionic point-
charge model coupled with an isotropic Sternheimer an-
tishielding factor. The interpretation of the data re-
quires a considerable amount of covalent character and
configurational interaction on the Na^+ ion. (Contractor's
abstract)

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Harvard U. [Cruft Lab.] Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE IN ALKALI
METAL ALLOYS (Abstract), by L. Rimal and N.
Bloembergen. [1959] [1]p. (Sponsored jointly by Air
Force Office of Scientific Research, Office of Naval Re-
search, and Signal Corps under [Nonr-186616])
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
186, Mar. 30, 1959.

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The ^{23}Na and ^{87}Rb resonances in Na-K and Na-Rb systems have been observed. The solid solubility is small but the components are completely miscible in the liquid phase. The Knight shifts in the liquid phase are linear functions of the relative concentration. Let K_0 be the Knight shift in the pure metal, K in the alloy with a solute concentration c . The value of $K_0^{-1} (\delta K / \delta c)$ is + 0.30 for Na in NaK, + 0.51 for Na in NaRb, and - 0.27 for ^{87}Rb in NaRb. These results agree rather well with recent theories. The line width of ^{23}Na increases on alloying, whereas the ^{87}Rb line width decreases with increasing c . Saturation data indicate that T_1 is proportional to T_2 . The change in T_1 calculated from the Korringa relation is much smaller than the observed change. The results can be explained if the effect of the spin-exchange interactions $A(\text{Na}) \cdot I(\text{Rb})$ and $A'I(\text{Rb})^{85}$. $I(\text{Rb})^{87}$ on T_1 and T_2 is taken into account.

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Harvard U. Cruft Lab., Cambridge, Mass.

TABLES OF COULOMB WAVE FUNCTIONS. VOLUME I. ($r = 2.0 - r = 8.3$), by M. Blume, N. Briggs, and H. Brooks. Apr. 1, 1959, 1v. Incl. tables. (Technical rept. no. 260, v. 1) (Sponsored jointly by [Air Force Office of Scientific Research], Office of Naval Research, and Signal Corps under Nonr-186616) AD 218751

Unclassified

The solutions and the derivatives of the solutions are tabulated of the differential equation

$$\frac{d^2 U^{(1)}}{dr^2} + \left[E + \frac{2}{r} - \frac{1(1+1)}{r^2} \right] U^{(1)} = 0$$

This is the radial part of the hydrogenic wave equation expressed in atomic units (energy in rydbergs and distance in Bohr radii). The tables are accurate to 7 significant figures. They run from $r = 2.0$ to $r = 5.0$ in intervals of 0.1, and from $\epsilon (= -E) = 0.07$ to $\epsilon = 1.20$ in intervals of 0.01. The functions are grouped so that all values of ϵ for a given r are adjacent in the tables. For each set of values of ϵ and r the solutions for $l = 0, 1, 2$ are listed consecutively. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

TABLES OF COULOMB WAVE FUNCTIONS. VOLUME II. ($r = 8.4 - r = 15.0$), by M. Blume, N. Briggs, and H. Brooks. Apr. 1, 1959, 1v. Incl. tables. (Technical rept. no. 260, v. 2) (Sponsored jointly by Air Force Office of

Scientific Research, Office of Naval Research and Signal Corps under Nonr-186616) AD 219947

Unclassified

A most extensive listing of Coulomb wave function computations is presented.

594

Harvard U. Cruft Lab., Cambridge, Mass.

STRESS AND TEMPERATURE DEPENDENCE OF THE PARAMAGNETIC RESONANCE SPECTRUM OF NICKEL FLUOSILICATE, by W. M. Walsh, Jr. [1959] [13]p. incl. illus. diagrs. refs. [Technical rept. no. 292] (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616]) AD 232202

Unclassified

Published in Phys. Rev., v. 114: 1473-1485, June 15, 1959.

The crystalline field splitting of the ground state of divalent nickel in the fluosilicate, $\text{NiSiF}_6 \cdot 6\text{H}_2\text{O}$, has been measured at room temperature as a function of hydrostatic pressure to $10,000 \text{ kg/cm}^2$ and uniaxial stress to 150 kg/cm^2 . The anisotropic compressibility and thermal expansion of this trigonal crystal have also been determined. Combining these data with the known variation of the splitting with temperature, its dependence on isothermal unit cell geometry and on temperature at constant unit cell dimensions is calculated. The splitting is found to be independent of volume within experimental error but proves to be quite sensitive to unit cell shape. The deduced explicit temperature dependence is 3 times larger than that measured at atmospheric pressure. The magnitude and geometrical variation of the crystalline field splitting may be qualitatively understood using a static, ionic model of the $(\text{Ni} \cdot 6\text{H}_2\text{O})^{2+}$ octahedral complex. A rather general analysis of the explicit temperature dependence indicates, however, that low-frequency lattice vibrations play a dominant role in determining the observed value of the splitting. The resonance line widths are observed to increase monotonically and quite nonlinearly with increasing pressure. This broadening is discussed in terms of isotropic and anisotropic exchange interactions. In agreement with earlier conclusions of Ollom and Van Vleck it is inferred that the 2 mechanisms are of comparable importance in this paramagnetic salt. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

PRESSURE DEPENDENCE OF THE PARAMAGNETIC RESONANCE SPECTRA OF TWO DILUTE CHROMIUM SALTS, by W. M. Walsh, Jr. [1959] [6]p. incl. diagrs.

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tables, refs. [Technical rept. no. 293] (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616]) AD 232203
Unclassified

Published in Phys. Rev., v. 114: 1486-1490, June 15, 1959.

The pressure dependences of the spin-Hamiltonian parameters of trivalent chromium in ammonium aluminum alum and potassium cobalticyanide have been measured up to $10,000 \text{ kg/cm}^2$ near room temperature. In the case of the alum, runs have been made at 0, 24 and 50°C . The g-value remains unchanged while the crystal-line field splitting, δ , increases by $\sim 30\%$, $(\partial\delta/\partial P)_T$ in-

creasing with rising temperature and pressure. Using an empirically determined equation of state the crystal-line field splitting variations are converted to isothermal volume and explicit temperature dependences. These are discussed in terms of static and dynamic crystal-line fields but are not satisfactorily explained. This failure is attributed to inhomogeneous internal deformation of the unit cell as a function of stress and temperature. A room temperature run on the covalent chromicyanide shows the g-value as well as the principal splitting parameter, D, to be nonmonotonic functions of pressure. The rhombic splitting parameter, E, increases quadratically with pressure. Since no attempt was made to determine the crystalline equation of state the resonance data are only qualitatively discussed. It is difficult to reconcile the results with the equivalent crystalline field model of the chromicyanide complex. (Contractor's abstract)

596

Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR RESONANCE STUDY OF ELECTRONIC MAGNETISM IN COPPER-NICKEL, by D. [L.] Weinberg and N. Bloembergen. July 13, 1959 [14]p. incl. diagrs. table, refs. (Technical rept. no. 307) (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 225350
Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 15: 240-248, Oct. 1960.

Alloying with 27, 38 or 43% Ni is found to produce extreme broadening and asymmetry of the NMR of Cu. Almost every observable Cu nucleus appears to undergo a decrease in magnetic field. The width between derivative peaks is increased by as much as 12 times. It is satisfactorily proportional to or independent of applied field, according as electronic paramagnetism (in the 27% alloy) or weak ferromagnetism is expected to be involved, but the central portion of the line expands in proportion to the field. The concentration dependences are much slower than that of the macroscopic magneti-

zation. Isotropic indirect exchange coupling between the Cu nuclei and the time average magnetic moments of the Ni atoms, and inhomogeneity of the Knight shift account for the measurements approx. It is necessary to include large contributions from Cu nuclei in noncubic environments. The field and concentration dependences are interpreted in terms of inhomogeneous electronic magnetism in the ferromagnetic alloys. The Ni paramagnetism cannot be identified in alloys of up to 15% Ni because of quadrupole effects. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

CROSS RELAXATION IN LiF, by P. S. Pershan. Aug. 1, 1959, 26p. incl. diagrs. refs. (Technical rept. no. 308) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 230334
Unclassified

Also published in Phys. Rev., v. 117: 109-116, Jan. 1, 1960.

A combined experimental and theoretical study of cross relaxation in LiF was carried out. In agreement with theory the cross relaxation time T_{21} , is observed to be strongly anisotropic and field dependent, at 51.7 gauss it goes from 0.025 sec in the [100] direction to 7 sec in the [111] direction. A frequency distribution function analogous to the line shapes for magnetic absorption is measured down to 10^{-4} times the maximum value; for most orientations a Gaussian is an excellent approximation to it. (Contractor's abstract)

598

Harvard U. Cruft Lab., Cambridge, Mass.

CROSS RELAXATION IN SPIN SYSTEMS, by N. Bloembergen, S. Shapiro and others. Oct. 15, 1958, 42p. incl. diagrs. refs. (Technical rept. no. 285) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 207205
Unclassified

Also published in Phys. Rev., v. 114: 445-459, Apr. 15, 1959.

The energy transfer between adjacent resonances in nuclear and electron spin systems is analyzed in terms of the overlap of line-shape functions. The procedure is an enlargement on the original proposal of Kronig and Buewkamp, and consists of taking partial account of off-diagonal elements in the spin-spin interaction, which are omitted in Van Vleck's truncated Hamiltonian. If the frequency of these off-diagonal elements is sufficiently small, they give rise to an additional kind of spin-spin relaxation, observed by Gorter and co-workers. They

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are also responsible for cross-saturation effects in paramagnetic salts of the type observed by Townes and co-workers. A crucial experiment is described which can be explained by spin-spin interactions, but not by the assumption of a hot-phonon region. Implications of the cross-relaxation for the operation of solid state masers are discussed. Special consideration is given to magnetically dilute substances and inhomogeneously broadened lines. Paradoxically, the latter will usually still undergo a homogeneous steady-state saturation. (Contractor's abstract)

590

Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE IN ANTIFERRO-MAGNETIC MnF_2 UNDER HYDROSTATIC PRES-SURE, by G. B. Benedek and T. Kushida. Oct. 30, 1959, 27p. incl. diagrs. tables, refs. (Technical rept. no. 315) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 230335

Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 183, Mar. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 118: 46-57, Apr. 1, 1960.

The nuclear magnetic resonance frequency of the F^{19} nucleus in antiferromagnetic MnF_2 , in zero external field, was measured as a function of pressure at 4.2°K, and 35.7°K using a new type VHF variable frequency spectrometer. From these measurements were deduced the pressure dependence of the hyperfine coupling constant (A) between the manganese electrons and the fluorine nucleus, and the pressure dependence of the Néel temperature. This deduction gives $(1/A)(dA/dP) = + (1.9 \pm 0.1) \times 10^{-6}/(kg/cm^2)$ and $(1/T_N)(dT_N/dP) = + (4.4 \pm 0.3) \times 10^{-6}/(kg/cm^2)$. Also measured was the compressibility of MnF_2 . The magnitude and pressure

dependence of A is explained using the theories of A. Mukherji and T. P. Das and W. Marshall and P. N. Stuart, which permit a calculation of the dependence of A on the interatomic distances, starting from the Hartree-Fock self-consistent field wave functions for Mn^{2+} and F^- with the Mn^{2+} wave functions properly adjusted to bring it into agreement with neutron scattering form factor measurements. The theory is in very good agreement with the experimental results. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE IN ALKALI AL-LOY SYSTEMS, NaK AND NaRb, by L. Rimai and N. Bloembergen. Nov. 20, 1959 [14]p. incl. diagrs. refs. (Technical rept. no. 314) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186616) AD 243874

Unclassified

Published in Jour. Phys. and Chem. Solids, v. 13: 257-270, 1960.

The Knight shift K in liquid NaK and NaRb systems is a linear function of the relative Na-concentration 1-C.

The relative variation $K^{-1}(\partial K/\partial C) = 0.361$ for Na^{23} in NaK, $= 0.518$ for Na^{23} in NaRb and $= 0.270$ for

Rb^{87} in NaRb. An interpretation in terms of the scat-tering theory of conduction electrons is given. The line width of the Na^{23} and Rb^{87} resonances is a non-linear function of C. It is about a factor 5 larger in the Rb-rich alloys than at the Na-rich end. This result can be explained by the electron-coupled spin exchange interac-tion between different nuclei. The remarkable fact that these spin-spin interactions do not average to a small value in the liquid metals necessitates the postulate of a long range character for the electron-coupled inter-action. The Knight shift and line width in solid terminal solutions have also been observed and compared with theory. The experiments show that nuclear magnetic resonance is particularly well suited to determine phase diagrams of alkali alloy systems. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

RELAXATION EFFECTS IN A MASEP MATERIAL, $K_3(CoCr)(CN)_6$, by S. Shapiro and N. Bloembergen. [1959] [6]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616])

Unclassified

Published in Phys. Rev., v. 116: 1453-1458, Dec. 15, 1959.

The rate equations for the occupation of spin levels are augmented to include cross-relaxation processes. It is confirmed experimentally that the latter are important when the concentration of magnetic ions is high or 2 resonances have a small separation. Maser action is usually impaired under such circumstances. When ex-perimental conditions are chosen such that cross-relax-ation effects are negligible, it is shown that all spin-lattice relaxation processes for Cr^{+++} in the cyanide are proportional to the absolute temperature in the

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liquid helium range. The susceptibilities at both the pump and maser frequencies follow the general theoretical dependence and reach asymptotic values as a function of pump power. (Contractor's abstract)

602

Harvard U. [Cruft Lab.] Cambridge, Mass.

NUCLEAR MAGNETIC RESONANCE INTENSITIES IN ALLOYS, by D. L. Weinberg. [1959] [12]p. incl. diagrs. tables, refs. (In cooperation with Harvard U. Gordon McKay Lab.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-186616]) Unclassified

Published in Jour. Phys. and Chem. Solids, v. 15: 249-260, Oct. 1960.

The steady state magnetic resonances of Cu^{63} , Al^{27} and Li^7 have been studied in the majority constituents of the Cu-Ni, Cu-Au, Al-Zn and Li-Mg alloy systems, over wide ranges of composition, magnetic field and temperature. Nuclear electric quadrupole effects are most prominent. The line widths, shapes and frequencies can be qualitatively understood in simple cases, but the predictions of the general statistical problem have not been obtained. Initial intensity reductions in copper alloys are consistent with screening of excess charge by conduction electrons and enhancement by antishielding factors. The field gradients seem to be primarily of charge origin when there is a valence difference, but those arising from size differences can be comparable. The intensity falls markedly less rapidly above about 20% solute in Cu-Ni and Cu-Au, and increases very strongly at about 40% Ni. The anomalous intensity is believed to arise from non-cubic configurations of solute atoms which give rise to small field gradients at the central nucleus. The influence of order in Cu-Au on the intensity is described better by the conventional long range order than short range order, because the former distinguishes between the Cu and Au sublattices. The predictions are compared with effects of heat treatment. (Contractor's abstract)

603

Harvard U. Cruft Lab., Cambridge, Mass.

THEORY OF CORNER-DRIVEN COUPLED SQUARE LOOP ANTENNAS, by S. Prasad. Feb. 1, 1959 [41]p. incl. diagrs. (Technical rept. no. 277) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 214679 Unclassified

A theory for 2 identical square loop antennas driven in the zeroth-phase sequence (voltages in phase at all 4 corners) and the 2nd-phase sequence (voltages alternately in and out of phase at the corners) is formulated. Eight independent integral equations are obtained. They

are solved individually by the method of iteration and 1st-order formulas are obtained for the current distributions and driving-point impedances. For each phase sequence, the sum of the symmetrical and anti-symmetrical impedances gives the self-impedance and the difference between them gives the mutual impedance. Self-and mutual impedances are also obtained for a superposition of the 2-phase sequences. (Contractor's abstract)

604

Harvard U. Cruft Lab., Cambridge, Mass.

SELF-AND MUTUAL IMPEDANCES OF STACKED ARRAYS OF SQUARE LOOP ANTENNAS, by S. Prasad. Feb. 5, 1959 [23]p. incl. diagrs. tables. (Technical rept. no. 278) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 218430 Unclassified

Stacked arrays of square loops driven in the zeroth-phase sequence (voltages in phase at all 4 corners) and the 2nd-phase sequence (voltages alternately in and out of phase at the corners) were studied. Self-and mutual impedances were calculated for each phase sequence and for a simple superposition of the 2 phase sequences using a modified zeroth-order theory. Self-and mutual impedances were obtained experimentally for the same superposition of the 2 phase sequences. (Contractor's abstract)

605

Harvard U. Cruft Lab., Cambridge, Mass.

RADIATION FIELD OF THE CORNER-DRIVEN SQUARE LOOP ANTENNA, by S. Prasad. Feb. 10, 1959 [31]p. incl. diagrs. tables. (Technical rept. no. 283) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220322 Unclassified

The radiation properties of square loop antennas driven in the zeroth-phase sequence (voltages in phase at all 4 corners), the 2nd-phase sequence (voltages alternately in and out of phase at the corners) and a simple superposition of the 2 phase sequences have been studied. The theoretical far-zone electric field has been obtained for each phase sequence and for the simple superposition of the 2 phase sequences. The radiation patterns have been obtained experimentally for the same cases. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

A CORNER-REFLECTOR ANTENNA DERIVED FROM THE SQUARE LOOP, by S. Prasad. Feb. 25, 1959, 11p.

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incl. illus. tables. (Technical rept. no. 287) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 218139
Unclassified

The circuit and field properties of a corner-reflector antenna derived from a square loop was studied. Input impedances and current distributions were obtained experimentally and compared with the theoretical results, for antennas of different sizes. Radiation patterns were also obtained for such antennas. (Contractor's abstract)

607

Harvard U. Cruft Lab., Cambridge, Mass.

AN EXPERIMENTAL STUDY OF A SLOT ANTENNA AND A THREE-ELEMENT COLLINEAR ARRAY OF SLOT ANTENNAS, by G. H. Owyang. May 15, 1959, 1v. incl. illus. table. (Technical rept. no. 291) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226952
Unclassified

The conventional transmission-line measuring techniques are shown to be applicable on a slot transmission line. The 2-slot transmission line is used to drive the slot antenna under study. The complementary normalized input impedance, the distribution of E'-field and the distribution of H'-field are measured as a function of the half-length of the slot antennas. The experimental results are then compared with the theory for a cylindrical antenna. Qualitative discussions are given to take account of the effect of the thickness of the ground plane. Similar study was made on a collinear array of slot antennas. (Contractor's abstract)

608

Harvard U. Cruft Lab., Cambridge, Mass.

EXPERIMENTAL STUDY OF A TWO-SLOT TRANSMISSION LINE, by G. H. Owyang. May 15, 1959, 1v. incl. diags. (Technical rept. no. 289) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226889
Unclassified

The experimental set-up which consists of 2 slot transmission line together with its probing system is described. The method for testing the balance of the 2-slot line is discussed. The measuring techniques on the slot transmission line are given. The transverse distribution of the longitudinal current and the attenuation constant of a 2-slot line are measured. (Contractor's abstract)

609

Harvard U. Cruft Lab., Cambridge, Mass.

THE MEASUREMENT OF THE LINE PARAMETERS OF THE TWO-SLOT LINE BY THE METHOD OF ANALOGY, by G. H. Owyang. May 15, 1959 [14]p. incl. illus. table. (Technical rept. no. 290) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226890
Unclassified

The analogy between the steady state field in a conducting medium and the electrostatic field in a dielectric is investigated. The expressions for the constants of a 2-slot line are derived in a form so that they can be easily evaluated from the experimental data obtained from the electrolytic tank. The measured results are compared with theoretical values. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

ON THE RADIATION PATTERN OF A BASE-DRIVEN ANTENNA OVER A CIRCULAR CONDUCTING SCREEN, by C. L. Tang. May 15, 1959 [13]p. incl. illus. tables. (Technical rept. no. 301) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220323
Unclassified

The radiation pattern of a base-driven antenna of length h over a circular ground screen of radius a is examined from the point of view of high-frequency diffraction theory. By the use of Babinet's principle, the antenna problem is shown to be reducible to a scalar problem of diffraction of an infinitesimal dipole field by a circular aperture in a plane acoustically soft screen. In the limit of large ka and $h \ll a$, the leading terms in an asymptotic development of the distant magnetic field are found. (Contractor's abstract)

611

Harvard U. Cruft Lab., Cambridge, Mass.

THE PRINCIPLE OF COMPLEMENTARITY FOR SLOT LINES AND ANTENNAS, by G. H. Owyang. May 15, 1959 [21]p. incl. diags. (Technical rept. no. 288) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226888
Unclassified

The principle of complementarity is reviewed and reformulated with particular reference to its application in the study of slot transmission lines and slot antennas. The properties of a dual circuit together with the restricting conditions are investigated. The pairs of several possible duals for a given arbitrary configuration are correlated. New quantities are defined for use in the discussion of the different types of circuits.

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A complete parallelism between the 2 wire-line and the 2-slot line is established for the ideal cases and is extended by approximation to include the practical cases. The line constants of the 2-slot line and of the 2-strip line were derived for both the ideal case and the practical case. (Contractor's abstract)

612

Harvard U. Cruft Lab., Cambridge, Mass.

THE SLOT ANTENNA WITH COUPLED DIPOLES, by G. H. Owyang. May 15, 1959, 1v. incl. diagrs. tables. (Technical rept. no. 302) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226951

Unclassified

The problem of an array consisting of a slot antenna and 2 symmetrically located cylindrical dipoles is formulated. Subjected to certain conditions, the approx distribution of the current along each antenna is obtained by the method of iteration. The radiation function, the coupling coefficients between the slot and the dipole, the relation between the magnetic current in the slot and the electric current in the dipole, and the input impedance of the slot in the presence of the dipoles were obtained. The experimental set-up for measuring the radiation patterns is described. The measured and the theoretical patterns are presented. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

HIGH-FREQUENCY DIFFRACTION BY A SPHERE, by C. L. Tang. May 25, 1959 [12]p. incl. illus. (Technical note no. 303) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220325

Unclassified

A systematic procedure is given for the determination of the asymptotic series directly from the Helmholtz equation and the boundary conditions for the field in the shadow region of a sphere illuminated by a plane wave at high frequencies. The first 2 terms in the series for the shadow region, including the regions near the axial caustic and the boundary layer near the surface of the sphere, are explicitly evaluated. The present procedure can be generalized to any smooth convex 3-dimensional object with a rotational symmetry, illuminated by a plane wave in the direction of the axis of rotational symmetry. (Contractor's abstract)

614

Harvard U. Cruft Lab., Cambridge, Mass.

A NUMERICAL STUDY OF AN UNFAMILIAR TYPE OF

IMPEDANCE, by W. F. Pickard and T. T. Wu June 1, 1959 [16]p. incl. diagrs. table. (Technical rept. no. 300) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 220324

Unclassified

A procedure is outlined for decomposing a rather general class of microwave impedances into 5 unique subclasses, and a method is indicated by which 3 of these can be studied by means of their voltage response functions. Of these 5 subclasses, only the 5th is unfamiliar. The computation of the response function is outlined for a special case of this 5th type, and selected numerical results are presented. (Contractor's abstract)

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Harvard U. Cruft Lab., Cambridge, Mass.

THE ELECTROPHORESIS OF A SPHERICAL PARTICLE, by W. F. Pickard. July 1, 1959 [37]p. incl. illus. (Technical rept. no. 304) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 231945

Unclassified

The problem of predicting the electrophoretic velocity of a spherical-charged particle in an infinite dielectric liquid containing impurities is re-examined. A model, somewhat different from those commonly used, is postulated, and the associated equations are formulated and are solved subject to certain approximations. The electrophoretic velocity U is found to be linear in the applied field and to vary algebraically in the parameter $\mu = ka$. Curves for determining $U(\mu)$ are presented. (Contractor's abstract)

616

Harvard U. Cruft Lab., Cambridge, Mass.

REFLECTION OF ELECTROMAGNETIC WAVES FROM SOUND WAVES, by H. J. Schmitt. Aug. 10, 1959 [18]p. incl. diagrs. (Technical rept. no. 310) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-186632) AD 226886

Unclassified

The reflection of electromagnetic waves normally incident on the wavefronts of a semi-infinite standing sound wave is discussed. By analogy with the Bragg reflection in optics, a maximum reflection occurs when the wavelength of the electromagnetic radiation in the sound perturbed region is twice the acoustic wavelength. Since the reflecting planes of maximum sound pressure disappear periodically, the reflected electromagnetic signal is modulated with the sound frequency. An experiment is described in which the Bragg reflection of 3 cm electromagnetic waves from a standing sound wave beneath a water surface is observed. (Contractor's abstract)

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Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON DEGREE OF APPROXIMATION BY BOUNDED HARMONIC FUNCTIONS, by J. L. Walsh. Apr. 1959, 28p. incl. refs. (AFOSR-TN-59-235) (AF 18(600)1461) AD 212005; PB 144468 Unclassified

Also published in Jour. Math. Pures et Appl., v. 39: 201-220, July-Sept. 1960.

If $u(x,y)$ is defined on an analytic Jordan curve C , a necessary and sufficient condition that $u(x,y)$ be of class $L(p,\alpha)$, $0 < \alpha < 1$, on C is that there exist functions $u_n(x,y)$ harmonic in a region D containing C satisfying $|u_n(x,y)| = AR^n$ in D and $|u(x,y) - u_n(x,y)| \leq A_1/n^{p+\alpha}$ on C . (Contractor's abstract)

618

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

NOTE ON INVARIANCE OF DEGREE OF POLYNOMIAL AND TRIGONOMETRIC APPROXIMATION UNDER CHANGE OF INDEPENDENT VARIABLE, by J. L. Walsh. Aug. 1959, 12p. (AFOSR-TN-59-593) (AF 18(600)1461) AD 217183; PB 144489 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1528-1533, Oct. 1959.

Various commonly used measures of degree of approximation are shown to be invariant under one-to-one analytic transformation of the independent variable. This is true for both approximation by polynomials in the complex variable and trigonometric approximation in the real variable. The methods used emphasize the invariance of degrees of approximation. (Contractor's abstract)

619

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

POLYNOMIALS OF BEST APPROXIMATION ON AN INTERVAL, by J. L. Walsh and T. S. Motzkin. Oct. 1959, 10p. (AFOSR-TN-59-854) (In cooperation with California U., Berkeley) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-1461 and Office of Naval Research) AD 228078; PB 144494 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1523-1528, Oct. 1959.

New results are indicated, partly without proof, on the analogous problems of approximation to a given continuous function on a closed finite interval E . (Contractor's abstract)

620

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

THE BILINEAR RELATION ON OPEN RIEMANN SURFACES, by R. D. M. Accola. Oct. 1959 [35]p. incl. diagr. (AFOSR-TN-59-951) (AF 18(600)1461) AD 228008; PB 144671 Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 143-161, July 1960.

Let Γ_h be the Hilbert space of square integrable harmonic differentials on an open Riemann surface W . If $\{\Omega_n\}$ is an exhaustion of W , let $A_1, B_1, \dots, A_{p(n)}, B_{p(n)}, \dots$ be a canonical homology basis, where $A_1, B_1, \dots, A_{p(n)}$ is a basis modulo dividing cycles of Ω_n . Let Γ_{he} be exact, Γ_{hse} be semi-exact, and Γ_a be analytic differentials. Let $\Gamma_{ho} = \Gamma_{he}^{\perp}$, and $\Gamma_{hm} = \Gamma_{hse}^{\perp}$. Let $\sigma(c)$ be the unique differential in Γ_{ho} such that $\int_{cp(n)} \omega = (\omega, \sigma(c))$, where c is a cycle. For $\omega \in \Gamma_{hse}$ let $T_n \omega = \sum_{k=1}^{p(n)} (\int_{B_k} \omega) \sigma(A_k) - (\int_{A_k} \omega) \sigma(B_k)$. It is said that the generalized bilinear relation (GBR) holds for $\omega \in \Gamma_{hse}$ if $(\tau, (T_n \omega)^*) \rightarrow (\tau, \omega^*)$ for all $\tau \in \Gamma_{ho}$. The GBR holds for ω if and only if the projections of $T_n \omega$ on Γ_{ho}^* are bounded. If $W \in O_{HD}$ let $\Phi_k \in \Gamma_a$ satisfy $\int_{A_j} \Phi_k = \delta_{jk}$. The validity of the GBR for all $\omega \in \Gamma_h$ implies that $\sum_{k=1}^{p(n)} (\int_{A_k} \alpha) \Phi_k \rightarrow \alpha$ strongly for $\alpha \in \Gamma_a$.

Parabolic surfaces exist where the GBR holds and does not hold. Let \mathcal{U} be the span of the $\sigma(A_k)$'s, \mathcal{B} the span of the $\sigma(B_k)$'s. If $W \in O_{HD}$ and $\mathcal{U} + \mathcal{B}$ is closed then $(\tau, (T_n \omega)^*) \rightarrow (\tau, \omega^*)$ whenever τ and ω have a finite number of non-zero A (or B) periods. Then the Φ_k 's span Γ_a . Examples of parabolic surfaces exist where $\mathcal{U} + \mathcal{B}$ is not closed. A surface exists where Γ_{hm} is a proper subset of $\Gamma_{he} \cap \Gamma_{ho}$. On this latter surface the GBR can hold for no canonical homology basis. (Contractor's abstract)

621

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

NOTE ON DEGREE OF APPROXIMATION BY BOUNDED ANALYTIC FUNCTIONS: PROBLEM β , by J. L. Walsh. Oct. 1959, 22p. incl. refs. (AFOSR-TN-59-952) (AF 18(600)1461) AD 228076; PB 144472 Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in Trans. Amer. Math. Soc., v. 96: 246-258, Aug. 1960.

A stronger result is presented of the relation between the degree of approximation on a point set E to the continuity properties on a different point set E' of the function $f(z)$ approximated. Integrated Lipschitz conditions are used in the hypothesis in place of Lipschitz conditions used in the general result previously discussed (HAR.05:006, Vol. II). The study is divided into 2 parts: (1) the study of the classes of functions involving Lipschitz conditions, and (2) applications to approximation by bounded analytic functions. (ASTIA abstract)

622

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON THE ASYMPTOTIC PROPERTIES OF EXTREMAL POLYNOMIALS WITH PRESCRIBED CONSTANT TERM, by J. L. Walsh. Oct. 1959, 14p. (AFOSR-TN-59-1037) (AF 18(600)1461) AD 228077; PB 144368

Unclassified

Also published in Math. Zeitschr., v. 73: 339-345, 1960.

The analog is studied of $\lim_{n \rightarrow \infty} \|T_n(z)\|^{1/n} = \tau(E)$, for the polynomials: $p_n(z) = z^n + a_1 z^{n-1} + \dots + a_n$ of least norm, where the numbers $a_n = A_n$ are prescribed. Under suitable conditions on the closed bounded set of the z -plane, E , necessary and sufficient conditions are obtained on the A_n that the analog be valid. (Contractor's abstract)

623

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

EXPANSIONS IN TERMS OF HEAT POLYNOMIALS AND ASSOCIATED FUNCTIONS, by P. C. Rosenbloom and D. V. Widder. [1959] [47]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1461 and Office of Naval Research under Nonr-71016)

Unclassified

Published in Trans. Amer. Math. Soc., v. 92: 220-266, Aug. 1959.

Let $V_n(x, t)$ be defined by $\exp(zx + z^2 t) = \sum V_n(x, t) z^n / n!$, and $W_n(x, t)$ by $k(x - 2z, t) = \sum W_n(x, t) z^n / n!$, where $k(x, t)$ is the fundamental solution of the heat equation. It is shown that V_n and W_n form a biorthogonal system and the questions involved in the expansion of functions in terms of a V or W series are thoroughly investigated. These questions include the determination of coefficients, the question of convergence, and the characterization of those functions for which the expansions are

possible. Asymptotic values of V_n and W_n are investigated and results in the L^2 theory are included. (Math. Rev. abstract)

624

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

PROOF THAT ANY BIRATIONAL CLASS OF NON-SINGULAR SURFACES SATISFIES THE DESCENDING CHAIN CONDITION, by O. Zariski. [1959] [11]p. (AFOSR-TN-59-89) (AF 18(600)1503) AD 210089

Unclassified

Also published in Mem. Coll. Sci., Kyoto U., Series A, v. 32: 21-31, 1959.

Proof is proposed for a descending chain condition for algebraic surfaces by elementary algebra-geometric considerations as follows: If P_n is a fundamental point of $F_n - F_{n-1}$ and \mathcal{C}_n is the cycle corresponding to P_n in $F_n - F$, it is verified that the set $\{\mathcal{C}_i\}$ contains an infinite subset $\{\mathcal{C}_{i_j}\}$ of maximal elements of the set. One can fix an irreducible exceptional curve \mathcal{E}_j for each \mathcal{C}_{i_j} , and it is proved that: (1) $\mathcal{C}_{i_j} \cap \mathcal{E}_k = \emptyset$; (2) $(D \cdot \mathcal{E}_j) = 1$ for all j , where D is a cycle of the anticanonical system $|-K|$ on F and the left hand side of (2) denotes intersection index of D and \mathcal{E}_j ; (3) the relation (2) holds for all D of a certain linear subsystem L of $|-K|$, hence \mathcal{E}_j is a component of one and only one cycle D_j of L ; (4) $(\mathcal{E}_j)^2 = 1$. The propositions (3) and (4) are in contradiction. (Math. Rev. abstract, modified)

625

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

ON FINITE GROUPS OF EVEN ORDER WHOSE 2-SYLOW GROUP IS A QUATERNION GROUP, by R. Brauer and M. Suzuki. [1959] [3]p. (AFOSR-TN-59-1173) (In cooperation with Illinois U., Urbana) (AF 49(638)287) AD 249161

Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1757-1759, Dec. 1959.

A proof is given of the following theorem: Let G be a group of finite even order. If the 2-Sylow group P of G is a quaternion group (ordinary or generalized), then G is not simple.

626

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

[ON THE REPRESENTATIVE THEORY OF GROUPS

AIR FORCE SCIENTIFIC RESEARCH

OF FINITE ORDER, II] Zur Darstellungstheorie der Gruppen endlicher Ordnung, II, by R. Brauer. [1959] [22]p. (AF 49(638)287) Unclassified

Published in Math. Zeitschr., v. 72: 25-46, 1959/1960.

The chief problem solved in this paper (theorem 7D) is that of determining the number k_r of ordinary irreducible representations of a finite group \mathfrak{G} which lie in the block B_r , for a prime p which divides the order g of \mathfrak{G} . The ideas introduced in Part I (Math. Zeitschr., v. 63: 403-444, 1956) are further developed and lead to a refinement of the whole modular representation theory, in the sense that the block structures of certain sub-groups \mathfrak{H} of \mathfrak{G} yield information concerning that of \mathfrak{G} . In order to state the main theorem (6A), 2 preliminary ideas are necessary. If G is any element of \mathfrak{G} it is well known that we may write $G = PR$, where P is p -singular, i.e., of order a power of p , and R is p -regular, of order prime to p ; each of P and R is a power of G and $PR = RP$. If $\mathfrak{N}(P)$ is the normalizer of P in \mathfrak{G} , $G \in \mathfrak{N}(P)$, so that we may write

$$\chi_i(PR) = \sum_j d_{ij}^P \omega_j^P(\mathfrak{N}),$$

where χ_i is any ordinary character of G and ω_j^P a modular character of $\mathfrak{N}(P)$; the d_{ij}^P are algebraic integers called generalized decomposition numbers, and they are independent of R . For $P = 1$, the ω_j^P are the modular representations ω_j of \mathfrak{G} and the d_{ij}^P the ordinary decomposition numbers of \mathfrak{G} . The second preliminary idea is that every block \tilde{B} of $\mathfrak{G} = \mathfrak{N}(P)$ arises by restricting \mathfrak{G} to \mathfrak{H} relative to some block B of \mathfrak{G} ; this relationship is written $\tilde{B} = B \uparrow \mathfrak{G}$, and § 2 of the paper is devoted to studying the conditions under which such a block B is uniquely defined. Theorem 6A then reads as follows: the generalized decomposition numbers d_{ij}^P can differ from zero only if χ_i belongs to the block $B = \tilde{B} \uparrow \mathfrak{G}$. From this main theorem follow certain results concerning the characters of \mathfrak{G} , in particular, theorem 7D, mentioned above: If B_1, B_2, \dots, B_t are the p -blocks of \mathfrak{G} , and if P_1, P_2, \dots, P_r is a representative set of p -singular elements of \mathfrak{G} such that $l_r(P_i)$ is the number of irreducible modular characters ω_j^P of $\mathfrak{N}(P_i)$ belonging to B with $\tilde{B} \uparrow \mathfrak{G} = B_r$, then the number of ordinary irreducible characters of \mathfrak{G} in B_r is given by $k_r = \sum_{i=1}^r l_r(P_i)$. (Math. Rev. abstract)

627

Harvard U. [Dept. of Mathematics] Cambridge, Mass.

COMPLETE IDEALS IN REGULAR LOCAL RINGS

OF DIMENSION 2, by O. Zariski. Dec. 1959, 29p. (AFOSR-TN-59-1114) (AF 49(638)494) AD 230077; PB 145484 Unclassified

The theory of complete ideals in polynomial rings $k[x, y]$ of 2 variables presents some striking features. This theory (Amer. Jour. Math., v. 60: 51-204, 1938) is presented in the appendix in a simpler form and in greater generality. The generalization consists in dealing with arbitrary regular local rings of dimension 2, rather than with that special class of such rings which come from quotient rings of $k[x, y]$ with respect to maximal ideals in $k[x, y]$. Very little is known about complete ideals in regular local rings of dimension greater than 2. It is almost certain that the theory developed here cannot be generalized to higher dimension without substantial modifications of both statements and proofs. (Contractor's abstract)

628

Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

KNIGHT SHIFT IN SUPERCONDUCTORS, by P. C. Martin and L. P. Kadanoff. [1959] [2]p. [AF 49(638)-589] Unclassified

Published in Phys. Rev. Lett., v. 3: 322-323, Oct. 1, 1959.

A suggested explanation is given of the fact that the Knight shift (and hence the electron spin susceptibility) does not vanish in superconductors at low temperatures. It is shown that the B.C.S. theory yields a non-zero susceptibility if the magnetic field is non-uniform, as in bulk metals.

629

Harvard U. [Lyman Lab. of Physics] Cambridge, Mass.

FIELD THEORY OF UNSTABLE PARTICLES, by J. Schwinger. [1959] [25]p. (AFOSR-1787) [AF 49(638)-589] AD 611513 Unclassified

Published in Proc. Ninth Internat'l. Annual Conf. on High Energy Phys., Kiev (USSR) (July 15-25, 1959), Moscow, 1960, Pt. 6, p. 54-89.

Also published in Ann. Phys., v. 9: 169-193, Feb. 1960.

Using the example of a spinless boson field, the structure of the simplest Green's function is developed to provide a uniform theory of particles, stable and unstable. Some attention is given to the time decay law of unstable particles and it is emphasized that a full account of the relevant physical situation must be contained in its mathematical representation, leading to the conclusion that an essential failure of the exponential decay law marks the limit of applicability of the physical concept of unstable particle. There is a brief discussion of the π and K mesons. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

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Harvard U. Mallinckrodt Chemical Lab., Cambridge, Mass.

INFRARED SPECTRA OF SiF_3H , SiF_3D , SiD_3F , AND SiD_3Cl , by C. Newman, S. R. Polo, and M. K. Wilson. [1959] [17]p. incl. diagrs. tables, refs. (AFOSR-TN-59-472) (AF 18(600)590) AD 262126 Unclassified

The infrared spectra of SiF_3H , SiF_3D , SiD_3F , and SiD_3Cl have been obtained under prism dispersion, and an assignment of fundamental modes has been made. All of these molecules exhibit C_{3v} symmetry and have 6 fundamental frequencies, 3 totally symmetric, C_{1v} , and 3 doubly degenerate.

631

Harvard U. Mallinckrodt Chemical Lab., Cambridge, Mass.

PERFLUOROALKYL DERIVATIVES OF TIN AND LEAD, by H. D. Kaesz, J. R. Phillips, and F. G. A. Stone. [1959] [2]p. (AFOSR-TN-59-950) (AF 49(638)-518) Unclassified

Also published in Chem. and Indus. (London), No. 45: 1409-1410, Nov. 7, 1959.

$\text{R}_3\text{PbC}_n\text{F}_{2n+1}$ (R = alkyl) type compounds were prepared from R_4Pb and $\text{IC}_n\text{F}_{2n+1}$ (I) under ultraviolet light, or by heating. A typical compound prepared in this way was $\text{Me}_3\text{PbC}_2\text{F}_5$ (II), bp 138.0° (by extrapolation of the vapor pressure equation). R_3SnCF_3 and $\text{R}_3\text{SnC}_2\text{F}_5$ were prepared in small yields from R_4Sn and CF_3I or $\text{C}_2\text{F}_5\text{I}$, however, CHF_3 and HC_2F_5 were the main products, as well as R_3SnF . $(\text{R}_3\text{Sn})_2$ with I gave $\text{R}_3\text{SnC}_n\text{F}_{2n+1} + \text{R}_3\text{SnI}$. The reaction proceeded readily to give Me_3SnCF_3 , mp -50.5° , bp 100.0° (extrapolation). Compounds containing CF_3 bonded to Sn or Pb showed strong infrared bands near 1158 and 1073 cm^{-1} (C-F). $\text{Me}_3\text{MC}_n\text{F}_{2n+1}$ (M = Sn or Pb) showed asymmetric and symmetric Me rocking modes near 790 and 730 cm^{-1} . In $\text{Ph}_3\text{MC}_2\text{F}_5$, C-C stretching appeared at 935 cm^{-1} (CS_2 solution). Sn compounds were vapor-chromatographed on diisodecyl phthalate, Pb compounds on Carbowax 4000. At 65° (He flow 180 cc/min) elution of Me_3PbCF_3 occurred in 13 min, while the elution time for II was 9 min. This is to be compared with an elution time of 2 min for Me_4Pb .

632

Harvard U. Mallinckrodt Chemical Lab., Cambridge, Mass.

PERFLUOROVINYL METALLIC COMPOUNDS, by H. D. Kaesz, S. L. Stafford, and F. G. A. Stone. [1959] [1]p. (AFOSR-TN-59-987) (AF 49(638)518) Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6336, Dec. 3, 1959.

In a brief communication to the editor the electronegativity of perfluoroalkyl groups is discussed. It is suggested that it is the tin-bonded carbon atom of the perfluoroalkyl group which is the relatively electron deficient center and not the tin-bonded carbon atoms of alkyl or aryl groups. It is also stated that many properties of the perfluorovinyl compounds contrast strikingly with those of their vinyl or perfluoroalkyl analogs.

633

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON SOME COVERING AND INTERSECTION PROPERTIES IN MINKOWSKI SPACES, by B. Grünbaum. [1959] [8]p. incl. refs. (AF 61(052)04) Unclassified

Published in Pacific Jour. Math., v. 9: 487-494, 1959.

This report is concerned with 2 numbers, E_X and J_X , determined by the geometric properties of X. They are defined as follows: (1) The expansion constant E_X is the greatest lower bound of real numbers $\mu \geq 0$ which possess the following property: Given any family $\{x_i + \alpha_i S; i \in I\}$ of mutually intersecting cells. (2) Jung's constant J_X of X is the greatest lower bound of real numbers μ which possess the following property: Given any family $\{x_i + S; i \in I\}$ of mutually intersecting cells. The main object of the present note is the determination of the exact upper bound of E_X for n-dimensional spaces X and the characterization of those spaces for which the bound is attained.

634

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ANALYTIC FUNCTIONS OF THE CLASSES L^2 AND t^2 AND THEIR KERNEL FUNCTIONS, by M. Maschler. Dec. 1958, 31p. incl. refs. (Technical scientific note no. 1) (AFOSR-TN-59-342) (AF 61(052)187) AD 213662 Unclassified

Also published in Rend. Circ. Matem. Palermo, Series II, v. 8: 163-177, May-Aug. 1959.

AIR FORCE SCIENTIFIC RESEARCH

Removable point sets for the Bergman kernel function are characterized completely. Necessary conditions on various kernel functions of essentially simply-connected domains are obtained, and are applied to the study of minimal and representative domains. (Contractor's abstract)

635

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON THE ITERATION PRODUCT OF SUMMABILITY METHODS. I. NEW CLASSES OF TRANSFORMATIONS AND PROPERTIES, by A. Jakimovski. Feb. 1959, 56p. incl. refs. (Technical scientific note no. 2) (AFOSR-TN-59-343) (AF 61(052)187) AD 213663

Unclassified

Two new classes of transformation, which might be looked upon, respectively, as the sequence-to-function analogues to the Hausdorff and quasi-Hausdorff transformations are defined and investigated. Their relation to the iteration product problem is shown. (Contractor's abstract)

636

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON DIVERGENCE OF RANDOM POWER SERIES, by A. Dvoretzky and P. Erdős. Feb. 1959 [8]p. (Technical scientific note no. 3) (AFOSR-TN-59-344) (AF 61(052)187) AD 213664

Unclassified

Also published in Michigan Math. Jour., v. 6: 343-347, 1959.

The following theorem is proved:

Let c_n , $n = 0, 1, 2, \dots$, be a monotone sequence of positive integers tending to zero and satisfying

$$\limsup_{n \rightarrow \infty} \frac{\sum_{j=0}^n c_j^2}{\log 1/c_n} > 0. \text{ If } a_n, n = 0, 1, 2, \dots, \text{ is a}$$

sequence of complex numbers satisfying $|a_n| \geq c_n$ for all sufficiently large n , then almost all series of $\sum (a_n z^n)$ are divergent everywhere on $|z| = 1$.

637

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON THE CONCEPT OF A DIFFERENTIALLY CLOSED FIELD, by A. Robinson. July 1959, 38p. incl. refs. (Technical scientific note no. 6) (AFOSR-TN-59-814) (AF 61(052)187) AD 226396; PB 145483

Unclassified

Also published in Bull. Israel Research Council, v. 8F: 113-128, Dec. 1959.

A concept of a differentially closed field is formulated which contains Kolchin's universal extension as a special case. Applications include a theorem on the specialization of parameters and a constructive version of Ritt's Nullstellensatz. (Contractor's abstract)

638

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

THE L_p APPROACH TO THE DIRICHLET PROBLEM.

PART I, by S. Agmon. Aug. 1959, 99p. incl. refs. (Technical scientific note no. 7) (AFOSR-TN-59-815) (AF 61(052)187) AD 226395; PB 145312

Unclassified

A Lipschitz L_p approach is presented to the Dirichlet problem, and to related regularity problems for higher order elliptic equations. The L_p approach is based on a L_p regularity theorem for very weak solutions of the Dirichlet problem. The regularity theorem is obtained by using the explicit solution of the Dirichlet problem for elliptic operators with constant coefficients in a half-space, and the L_p estimates for such solutions.

The basic regularity theorem is given both in the interior and at the boundary. When the simpler problem of interior regularity is considered, the weak solutions of overdetermined elliptic systems are also considered, and the L_p estimates are derived for such solutions.

The regularity theorem is combined with some general results on Banach spaces to develop the L_p existence theory for the Dirichlet problem. (Contractor's abstract)

639

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

THE PRODUCT OF SUMMABILITY METHODS. II. NEW CLASSES OF TRANSFORMATIONS AND THEIR PROPERTIES, by A. Jakimovski. Aug. 1959 [76]p. (Technical scientific note no. 2, pt. 2) (AFOSR-TN-59-816) (AF 61(052)187) AD 232071; PB 146101

Unclassified

Two new classes of transformation, which might be looked upon, respectively, as the sequence-to-function analogues to the generalized (and quasi-) Hausdorff transformation are defined and investigated. (Contractor's abstract)

640

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

LOCAL DIFFERENTIAL ALGEBRA, by A. Robinson.

AIR FORCE SCIENTIFIC RESEARCH

May 1959, 61p. (Technical scientific note no. 4)
(AFOSR-TN-59-817) (AF 61(052)187) AD 220569;
PB 145311 Unclassified

A consistency condition is obtained for a system of algebraic differential equations with given initial values. Theories are developed for ideals, polynomial ideals, and corresponding varieties. The starting point is a differential ring whose elements, at a given point, are represented by a homomorphic mapping into an ordinary ring.

641

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

ON SOME COMPOSITIONS OF HADAMARD TYPE IN CLASSES OF ANALYTIC FUNCTIONS, by C. Loewner and E. Netanyahu. June 1959, 6p. (Technical scientific note no. 5) (AFOSR-TN-59-843) (AF 61(052)187) AD 220708; PB 145310 Unclassified

Also published in Bull. Amer. Math. Soc., v. 65: 284-286, July 1959.

Let S be the class of regular, and Schlicht functions in

the unit circle. Let $f(Z) = \sum_{n=1}^{\infty} a_n z^n$, $a_1 = 1$ and

$g(Z) = \sum_{n=1}^{\infty} b_n z^n$, $b_1 = 1$, be the representing power series

of 2 elements of S . Then the composition $h(Z) =$

$\sum_{n=1}^{\infty} \frac{a_n b_n z^n}{n}$ leads to an element of the same class.

The weak conjecture that $h(z)$ has a non-vanishing derivative in $|z| < 1$ is proved to be false.

642

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

RESEARCH IN THE AREA OF MATHEMATICAL ANALYSIS, by S. Agmon, A. Dvoretzky, and A. Robinson. Annual summary rept. Oct. 1959, 19p. (AFOSR-TR-59-100) (AF 61(052)187) AD 232061; PB 146099 Unclassified

This report summarizes the work done under this contract to date. Agmon's work deals mainly with a new L_p approach to the Dirichlet problem and to related regularity problems for higher order elliptic equations (item no. 638). A typical regularity result is presented. Dvoretzky's subject was on rearrangement of series; comparison of densities of sequences (item no. 636) and a short recap of his work is presented also. The investigations of Robinson are published in 2 parts (item nos. 637 and 640) and are concerned with initial

value problems and differential algebra. The results of Netanyahu's investigations are also presented in brief. His subject, univalent functions, is discussed in detail in another publication (item no. 641). Tauberian theorems and summability are discussed by Jakimowski (item nos. 635 and 639). The heuristic theorem is discussed briefly here. The investigations of Marchler were concerned with the Bergman kernel and sought to find properties of its function of a planar domain D . The results, presented here in abstract form, are discussed fully in another report (item no. 634).

643

Hebrew U. [Dept. of Mathematics] Jerusalem (Israel).

THE SEQUENCE-TO-FUNCTION ANALOGUES TO HAUSDORFF TRANSFORMATIONS, by A. Jakimowski. [1959] [20]p. incl. refs. [AF 61(052)187] Unclassified

Published in Bull. Research Council, Israel, v. 8F: 135-154, Nov. 1959.

A class of transformations-the J transformations (which might be looked on as the sequence to function analogues to the Hausdorff transformations) is defined. The basic properties of the J transformations are given; and inclusion relations between the iteration product of J and Hausdorff transformations and the J transformations are given. (Contractor's abstract)

644

Hebrew U. Dept. of Physics, Jerusalem (Israel).

DETERMINATION OF RELATIVE ABUNDANCE, RATIO OF MAGNETIC MOMENTS, RATIO OF CAPTURE CROSS-SECTIONS OF GADOLINIUM ISOTOPES BY MEANS OF PARAMAGNETIC RESONANCE SPECTRUM, by W. Low and D. Shaltiel. Nov. 1958 [10]p. incl. tables. (Technical note no. 5) (AFOSR-TN-59-84) (AF 61(052)59) AD 210144; PB 138711 Unclassified

Presented at Forty-fourth Nat'l. Congress of the Italian Phys. Soc., Palermo (Italy), Nov. 6-11, 1958.

Abstract published in Nuovo Cimento, Series X, Suppl., v. 11: 468, 1959.

Precision of the hyperfine structure of the transitions corresponding to $\Delta M = 4$ of the cubic field paramagnetic resonance spectrum of gadolinium in single crystals of thorium oxide yields the following values: Isotopic abundance: Even isotopes - 69.45%; Gd^{155} - 15.05 \pm 0.2%; Gd^{157} - 15.5 \pm 0.2%. Ratio of magnetic moments $\frac{\mu^{155}}{\mu^{157}} = 0.7495 \pm 0.0045$. Crystals irradiated at the Harwell pile with a thermal neutron flux of 1.2×10^{12}

AIR FORCE SCIENTIFIC RESEARCH

$n/cm^2/sec$, and a fast flux of $2.3 \times 10^{11} n/cm^2/sec$, yields the ratio of nuclear capture cross-sections $\frac{\sigma_{157}}{\sigma_{155}} = 2.82$, using the above abundance values. No F center spectrum was detected in crystals irradiated with a total neutron flux of about $10^{18} n/cm^2$. The paramagnetic resonance spectrum of gadolinium in irradiated crystals is unchanged indicating negligible radiation damage in the neighborhood of the paramagnetic ions. (Contractor's abstract)

645

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC RESONANCE OF S STATE IONS IN STRONTIUM CHLORIDE, by W. Low and U. Rosenberger. [1959] [12]p. incl. table, refs. (Technical note no. 6) (AFOSR-TN-59-416) (AF 61(052)59) AD 214563; PB 140803 Unclassified

Also published in Phys. Rev., v. 116: 621-623, Nov. 1, 1959.

Paramagnetic resonance spectra were observed of Mn^{2+} , Gd^{3+} and Eu^{2+} in single crystals of strontium chloride grown from the melt. The Mn^{2+} shows a very small cubic field splitting a $< 1 \times 10^{-4} cm^{-1}$ and a hyperfine structure constant of $A = 81.2 \times 10^{-4} cm^{-1}$, indicating some covalent bonding. The Gd^{3+} and Eu^{2+} have cubic symmetry with splitting parameters; Gd^{3+} : $c = \pm (39.6 \pm 0.1) \times 10^{-4} cm^{-1}$, $d = \mp (0.2 \pm 0.1) \times 10^{-4} cm^{-1}$, $g = 1.9906 \pm 0.001$; for Eu^{2+} : $c = (52 \pm 5) \times 10^{-4} cm^{-1}$, $A^{151} = (34.5 \pm 0.3) \times 10^{-4} cm^{-1}$, $A^{153} = (15.5 \pm 0.3) \times 10^{-4} cm^{-1}$, $g = 1.995 \pm 0.001$. The smaller cubic field splittings in $SrCl_2$ compared with CaF_2 seem to favor a mechanism responsible for cubic-field splitting which is linear in the crystal potential terms. (Contractor's abstract)

646

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC SUBSTANCES SUITABLE FOR MASER OPERATION IN THE MILLIMETER RANGE, by W. Low. June 1959 [21]p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-59-675) (AF 61(052)59) AD 218387 Unclassified

Also published in Proc. Symposium on Millimeter Waves, New York, N. Y. (Mar. 31-Apr. 2, 1959), Brooklyn, Polytechnic Inst. of Brooklyn Press [1960] p. 45-56.

Requirements of continuous wave masers are listed. They include proper energy level spacings, relaxation times, line width, low dielectric losses, chemical stability, good thermal conductivity, and stable energy level scheme. These requirements are met by a number of ions in ionic lattices in the cm range. In the mm range only very few paramagnetic substances in usual crystal symmetries have the required energy splittings suitable for maser operation.

647

Hebrew U. Dept. of Physics, Jerusalem (Israel).

PARAMAGNETIC RESONANCE SPECTRA OF CHROMIUM AND MANGANESE IN THE SPINEL STRUCTURE, by R. Stahl-Brada and W. Low. June 1959, 12p. incl. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-59-961) (AF 61(052)59) AD 226397 Unclassified

Also published in Phys. Rev., v. 116: 561-564, Nov. 1, 1959.

The paramagnetic resonance spectrum of Cr^{3+} was measured on the single crystal of ruby spinel $MgAl_2O_4$ at the wavelengths of 3 cm, 1.2 cm and 8.6 mm. The spectrum confirms that Cr^{3+} is at a 'B' site and can be described with an axial spin Hamiltonian $S = \frac{3}{2}$, $2D = 0.990 \pm 0.005 cm^{-1}$, $g_{||} = 1.986 \pm 0.001$, $g_{\perp} = 1.989 \pm 0.002$. The paramagnetic resonance spectrum of Mn^{2+} was measured on the single crystal of $ZnAl_2O_4$ at 3 cm. The spectrum consists of 6 nearly isotropic lines with $A = 74.9 \pm 0.5 \times 10^{-4} cm^{-1}$, $g = 2.000_2 \pm 0.001$. The cubic or axial splitting was less than $8 \times 10^{-4} cm^{-1}$. The spectrum is indicative that Mn^{2+} is located at an 'A' site. (Contractor's abstract)

648

Hebrew U. Dept. of Physics, Jerusalem (Israel).

TABLES OF EIGENVALUES AND MATRIXELEMENTS OF TRANSITION PROBABILITIES FOR AN AXIAL SPIN HAMILTONIAN WITH $S = 3/2$, by R. Stahl-Brada and W. Low. July 1959, 1v. incl. tables. (Technical note no. 9) (AFOSR-TN-59-1125) (AF 61(052)59) AD 232062; PB 146717 Unclassified

Also published in Nuovo Cimento, Series X, Suppl., v. 15: 290-334, 1960.

Numerically computed eigenvalues of the matrix corresponding to the axial spin Hamiltonian $\mathcal{H}_S = g\beta H \cdot S + D(S_z - \frac{1}{3}S(S+1))$ with the spin number $S = 3/2$ are tabulated. These tables ($I_{50} - I_{85}$) are given for

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various values of θ , the angle between the magnetic field and the crystalline axis in steps of 5° to 85° , and for the dimensionless parameter $x = \frac{g\beta H}{4D}$ taking on various values between 10 and 0.05. The matrix elements $|\langle M | J_x | M' \rangle|^2$ and $|\langle M | J_z | M' \rangle|^2$ are tabulated for the same range of angles θ and the parameter x . With the help of these matrix elements the transition probability corresponding to transitions $M \rightarrow M'$ can be evaluated. (Contractor's abstract)

649

Hebrew U. Dept. of Physics, Jerusalem (Israel).

RATIOS OF RELATIVE ABUNDANCE, MAGNETIC MOMENTS, AND CAPTURE CROSS SECTIONS OF GADOLINIUM ISOTOPES FROM PARAMAGNETIC RESONANCE SPECTRUM, by W. Low and D. Shaltiel. [1959] [3]p. incl. tables. (AFOSR-3091) [AF 61(052)59] Unclassified

Published in Phys. Rev., v. 115: 424-426, July 15, 1959.

Precision measurements on the hyperfine structure of the transitions corresponding to $\Delta M = 4$ of the cubic-field paramagnetic resonance spectrum of gadolinium in single crystals of thorium oxide yield the following values: isotopic abundance: even isotopes, 69.45%; Gd^{155} , $15.05 \pm 0.2\%$; Gd^{157} , $15.5 \pm 0.2\%$. Ratio of magnetic moments: $\mu^{155}/\mu^{157} = 0.7495 \pm 0.0045$. Irradiation of crystals at the Harwell pile with a thermal neutron flux of 1.2×10^{12} n/cm² sec, and a fast flux of 2.3×10^{11} n/cm² sec, yields the ratio of nuclear capture cross sections $\sigma^{157}/\sigma^{155} = 2.82$, using the above abundance values. No F-center spectrum was detected in crystals irradiated with a total neutron flux of about 10^{18} n/cm². The paramagnetic resonance spectrum of gadolinium in irradiated crystals is unchanged, indicating negligible radiation damage in the neighborhood of the paramagnetic ions. (Contractor's abstract)

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Hebrew U. Dept. of Physics, Jerusalem (Israel).

THE GERMANIUM $CuK\alpha$ (2,2,2) DOUBLE X-RAY REFLECTIONS. I. INDEXATION, by E. Alexander, B. S. Fraenkel, and Z. H. Kalman. Apr. 1959 [16]p. incl. illus. diagr. tables. (Technical rept. no. 1) (AFOSR-TN-59-625) (AF 61(052)222) AD 217689; PB 143013 Unclassified

A method is developed to calculate the azimuthal positions of the double x-ray reflection points as they appear on a double reflection x-ray camera exposure.

The germanium $CuK\alpha$ (2,2,2) double reflection points are identified according to their measured positions on a film. (Contractor's abstract)

651

Hebrew U. Israel Inst. of Applied Social Research, Jerusalem.

A STOCHASTIC FACET THEORY OF SOCIAL INTERACTION IN THE DYAD, by W. G. Foa and S. Zacks. Apr. 1959, 33p. incl. tables, refs. (Technical scientific note no. 1) (AFOSR-TN-59-446) (AF 61(052)121) AD 214808 Unclassified

A model is described which attempts to predict how the reciprocal behavioral expectations of 2 interacting persons change in time as a result of their intervening perceptions of behavior. It is shown that the probability of a given future behavior of a person can be predicted from the knowledge of what he did before and of the reaction of the other to his earlier behavior. The transitional probabilities of this process are not constant and are obtained by applying the reinforcement schedule to the probabilities of the preceding stage. The process is determined by the initial probabilities and by the reinforcement schedule. Each probability tends to a limit which is independent of the initial probability. (Contractor's abstract)

652

Heidelberg U. (Germany).

FOURTH "BROOKHAVEN" CONFERENCE ON MOLECULAR BEAMS, Heidelberg U. (Germany) (June 9-11, 1959). 1959, 40p. incl. tables. (AFOSR-TR-59-152) AD 228005 Unclassified

Preliminary results and data of experiments at date still in progress were presented at the present conference. The program was an informal exchange of information and emphasized the preliminary nature of the results, much of which might be only tentative.

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Henri-Rousselle Hospital, Paris (France).

RELATION OF THE VISCERAL AFFERENTS ON THE ACTIVITY OF THE BRAIN STEM RETICULAR FORMATION. PART I. CONTROL OF AFFERENT RETICULAR AND CORTICAL ACTIVITIES. PART II. CENTRAL EFFECTS OF HYPOXIA AND THEIR CONSEQUENCES IN THE FIELD OF VIGILANCE AND MUSCULAR TONE, by P. C. Dell. [Final] technical rept. [1959] [16]p. (AFOSR-TR-59-93) (AF 61(514)1100 and AF 61(052)45) AD 219422; PB 143587 Unclassified

Pt. I: Experimental results suggested that the reticular facilitatory descending system of Rhines and Magoun

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and the reticular ascending system of Moruzzi and Magoun are a single functioning unit. This is good supporting evidence for theorizing that the "activating potentiality" of afferent messages is a function of their admittance into the reticular network. This admittance depends upon the control exercised by the cortex on the reticular activity. Pt. II: Neurogenic and humoral effects of hypoxia on the ascending and descending reticular systems were presented. Direct effects of hypoxia at the cortical level and the ensuing release phenomena were discussed. A summary of the factors at hand and their temporal interplay was given.

654

Herner and Co., Washington, D. C.

BASIC RESEARCH RESUMES. A SURVEY OF BASIC RESEARCH ACTIVITIES IN THE AIR RESEARCH AND DEVELOPMENT COMMAND, ed. by S. Herner. Dec. 1959, 334p. Incl. refs. (AFOSR-TR-59-204) (AF 49-638)652 AD 232933; PB 161291 Unclassified

All basic research activities which can clearly and formally be identified as comprising the ARDC basic research program are described. This includes some 1400 scientific efforts with leading universities, research institutions and industrial laboratories in the U. S. and the Free World. The following 6 technical program areas are covered: (1) Propulsion; (2) Materials; (3) Electronics; (4) Geophysics; (5) Biosciences; and (6) Aeromechanics.

655

Horizons, Inc. Dept. of Chemistry, Cleveland, Ohio.

MAGNETIC SUSCEPTIBILITIES OF PRASEODYMIUM AND TERBIUM OXIDES, by R. C. Vickery and A. Ruben. [1959] [4]p. incl. diagr. tables, refs. (AF 49(638)80) Unclassified

Published in Jour. Chem. Soc. (London), v. 106: 510-513, Feb. 1959.

Magnetic susceptibility-temperature measurements below 300° of 3 oxides of praseodymium and 3 of terbium over a range of temperature yield magnetic moments for Pr_2O_3 , Pr_6O_{11} , and PrO_2 of 3.55, 2.77, and 2.51 Bohr magnetons respectively and for Tb_2O_3 , Tb_4O_7 , and Tb_6O_{11} of 9.62, 8.70, and 8.49. The Curie-Weiss law is obeyed. The values agree well with theoretical ones

for the proposed formula. (Contractor's abstract)

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Human Sciences Research, Inc., Arlington, Va.

A CONCEPTUAL FRAMEWORK FOR THE INTEGRATION OF SMALL GROUP RESEARCH INFORMATION, by I. Altman and J. E. McGrath. Feb. 1959, 1v. incl. diagrs. tables, refs. (Rept. no. HSR-TN-59/1-GN) (AFOSR-TN-59-252) (AF 49(638)256) AD 212252; PB 140706 Unclassified

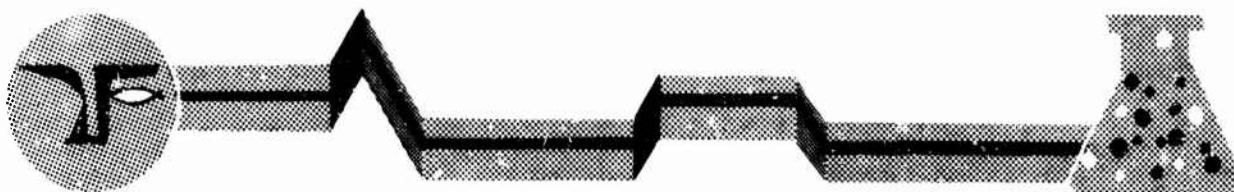
The results of the 2nd phase of a research program designed to integrate small group research information are presented. The pilot phase was reported in item no. PSY.01:001, Vol. II. The present approach has 2 distinctive features: (1) it is data-oriented; that is, the integrative system deals with existing empirical research results in detail, rather than on a general and gross level, and (2) the classification system utilized in the study is one based on the form or syntax of empirical data, rather than on content or substantive distinctions. Application of the syntactical framework to classification of small group research results provides a means for empirical validation of the logic of the framework. A description is presented of the classification system for integrating small group research information, and procedures for applying it to small group studies are outlined. Some major potential applications of the research to basic and operational problem areas are discussed. A coder instruction manual is appended to this report.

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Human Sciences Research, Inc., Arlington, Va.

THE TRANSLATION OF SMALL GROUP RESEARCH INFORMATION FOR COMPUTER ANALYSIS, by I. Altman, J. P. Jenkins, and J. E. McGrath. Oct. 1959 [73]p. incl. diagr. tables. (Rept. no. HSR-TN-59-59/9-GN) (AFOSR-TN-59-1194) (AF 49(638)256) AD 230241 Unclassified

This report presents the results of one aspect of a research program designed to develop and apply a classification system to synthesize small group research knowledge. It sets forth a data translation system which will be used to process a large amount of data currently being collected as a result of application of the classification system. The appendix to the report describes detailed rules and procedures for applying the translation system.



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Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

THE RADIATION CHEMISTRY OF FLUORINATED
ORGANIC COMPOUNDS, by P. Y. Feng. [1958] [5]p.
incl. diagrs. tables. refs. [AF 18(603)121]

Unclassified

Published in Proc. Second UN Internat'l. Conf. on
Peaceful Uses of Atomic Energy (Geneva), v. 29: 166-
170, 1958.

Although organic chlorine compounds are particularly
radiation sensitive compounds on the basis of radical
yield determinations, organic fluorine compounds are
expected to exhibit different radiation chemical be-
havior as a result of the extremely strong C-F bond.
This expectation is borne out by dpph experiments,
which show that the radical yields of either solutions of
CF₄, CHF₃, C₆H₅F or C₆H₅CF₃ in benzene, or pure
C₆H₅F or C₆H₅CF₃, are of the order of unity or less,
and are considerably lower than those of the corre-
sponding chlorine compounds. Mixtures of benzene
and carbon tetrafluoride produce upon irradiation vari-
ous amounts of fluorobenzene, benzo-trifluoride, fluoro-
form and perhaps also hydrogen fluoride depending on
the composition of the irradiated system. Under favor-
able conditions, the combined G values of the fluoro-
aromatic products amounted to 2.5, which cannot be ac-
counted for by a purely radical mechanism. Inasmuch
as chain reaction is also not applicable for the observed
product formation, other processes, for example the
ion-molecule processes, are believed to be operative
in the reaction mechanism.

659

Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

REVIEW OF RADIATION CHEMISTRY PAPERS PRE-
SENTED AT THE 2ND GENEVA CONFERENCE, by
P. Y. Feng. [1959] 41p. incl. tables, refs. (AFOSR-
TN-59-365) (AF 18(603)121) AD 231085; PB 145655
Unclassified

Condensation of papers presented at the Second UN
Conf. on the Peaceful Uses of Atomic Energy (Geneva
(Switzerland), Sept. 1958.

A review of the papers presented for oral presentation
at the Radiation Chemistry sessions is presented in-
cluding topics on elementary processes, detection of
intermediates, irradiation facilities, aqueous systems,
organic systems, polymers, catalysts, and reactions
of hot atoms. It is hoped that the material condensed
will serve as a source of general information to scien-
tific workers in related fields as well as a convenient
abstract for specialists in the field of radiation chemi-
cal research.

660

[Illinois Inst. of Tech.] Armour Research Foundation,
Chicago.

HIGH INTENSITY FLASH RADIOLYSIS OF n-HEXADE-
CANE (Abstract), by P. Y. Feng. [1959] [1]p. [AF 18-
(603)121] Unclassified

Presented at meeting of the Phys. Chem. Div. of the
Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Published in 135th meeting of the Amer. Chem. Soc.
Abstracts of Papers, 1959, p. 56-R.

The radiolysis of n-hexadecane with a high intensity,
pulsed electron source is reported. Pulse rates at 15,
30, 60, 120, and 180/sec (10 microsec pulse length)
were used in the experiments. The radiation energy
input during each pulse amounted to 2.3×10^8 rads/sec.
Within the limits of experimental accuracy, there is no
observable effect of pulse rate on either the gas yield
or the extent of trans-C = C group formation. The gas-
eous products are largely hydrogen, and the G(H₂) val-
ues are approximately 5. This value is considerably
higher than those obtained with continuous low intensity
irradiations reported in the literature, and is ex-
plained by the reduced probability of alkyl-hydrogen
recombination in the reported system. Up to a total
dose of 10^8 rads, the G(H₂) values remain practically
constant, whereas the yield of the C = C groups is seen
to decrease with increased dose. This is explained on
the basis of the competition of the olefinic products
with the original hydrocarbon for the absorbed radia-
tion energy, and the reduced probability for the reac-
tive species to attain macroscopic spatial equilibrium
in the high intensity pulsed irradiation system.

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Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

EXPERIMENTAL MEANS OF DETERMINING WAVE
PROPAGATION PHENOMENA IN SOLIDS, by A. J.
Durelli and W. F. Riley. Final rept. Oct. 1, 1956-Feb.
28, 1959. 15p. incl. refs. (AFOSR-TR-59-21) (AF 18-
(603)144) AD 211667 Unclassified

Methods of photoelasticity and grids in conjunction with
low-modulus materials were developed as means for
studying wave propagation in solids. A number of low
modulus materials were studied and Hysol 8705 (a ure-
thane rubber compound) was selected as the model ma-
terial. A complete study of its mechanical and optical
properties was made under static and dynamic loadings.
The modulus of elasticity was dependent upon the rate
of loading and the specific energy loss for the material
was about 10% for the stress ranges associated with
photoelastic determinations. The specific problems
studied included struts subjected to axial impact, disks

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subjected to diametrical impact, plates subjected to explosive loads on the boundary, and wave propagation past various geometric discontinuities in rectangular bars. (Contractor's abstract)

662

Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PROPERTIES OF SULFIDE SEMICONDUCTORS, by J. W. Buttrely, I. Siegel and others. Technical rept. no. 2, Jan. 1, 1958-Dec. 31, 1958. Feb. 1959, 18p. incl. diagrs. table, appendices. (AFOSR-TR-59-4) (AF 49(638)112) AD 208757; PB 138736 Unclassified

The fabrication of metal-sulfide type semiconductors and their properties were studied; emphasis was placed on As_2Te_3 and Sb_2Se_3 . An As_2Te_3 sample with an impurity of 1.9% Sb showed a Hall mobility of 6650 sq cm/volt-sec with a resistivity of 5.53×10^{-4} ohm-cm and carrier density of 0.17×10^{19} at room temperature. The mobility value is more than an order of magnitude larger than that of any other sample studied. Samples of As_2Te_3 and Sb_2Se_3 were characterized by measuring sample resistivity as a function of temperature up to 300°C, together with Hall effect measurements at room temperature. The results indicated that (1) from 71° to 258°C the variation of carrier concentration with temperature is insignificant compared to the change of carrier mobility, and (2) the observed increase of sample resistivity with increasing temperature is mainly due to decreasing carrier mobility caused by lattice scattering of the charge carrier. Specimen resistivity values vs temperature data indicated that temperatures sufficiently high for intrinsic activation energy calculations were not reached.

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Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PRESSURE EFFECTS IN LUMINESCENCE. PART II. ISOBARIC EXPERIMENTS ON NaI(Tl) , by L. Reiffel. Feb. 2, 1959 [26]p. incl. diagrs. refs. table. (Technical note no. 2) (AFOSR-TN-59-6) (AF 49(638)113) AD 208302 Unclassified

Also published in Phys. Rev., v. 114: 1493-1499, June 15, 1959.

The effect of steady-state hydrostatic pressure on the properties of luminescent systems, with particular reference to the phosphorescence of NaI(Tl) , is examined. It is shown that readily observable changes in decay mean life may be produced by very modest pressures. An interpretation of these effects is developed from a configurational coordinate model and also from thermodynamic considerations. Experimental results are

in good agreement with these theoretical expectations. For a 0.66-ev trap in NaI(Tl) , the change in center volume at the point of transition from metastable to emitting state is found to be $+17.5 \times 10^{-24} \text{ cm}^3$. Assuming a specific model for the center allows computation of the sign and magnitude of the critical displacement of ions required for trap collapse — in this case +0.19A. The force constant for the metastable state is computed to be 5.8×10^5 dynes/cm; and the vibrational frequency, assuming an effective mass equal to six I^- ions, is $3.4 \times 10^{12} \text{ sec}^{-1}$ corresponding to a zero point energy for this trap of 0.007 ev and cross over at a vibrational quantum number of about 47. The transmission coefficient for cross-over to the emitting state appears to be of the order of 0.03 per cent. Other possible experiments involving steady-state or transient pressure effects are outlined. (Contractor's abstract)

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Illinois Inst. of Tech. Armour Research Foundation, Chicago.

PRESSURE EFFECTS AND CONFIGURATION COORDINATE MODELS OF KCl(Tl) , by L. Reiffel. July 24, 1959 [7]p. incl. diagr. table. (Technical note no. 3) (AFOSR-TN-59-761) (AF 49(638)113) AD 225665; PB 143523 Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 215-217, Sept. 1, 1959.

The pressure effects and configuration coordinate models of KCl(Tl) were studied by using, as the phosphor, a single KCl crystal grown from a melt containing 0.00018 Tl (mol fraction). Separation of the 3050A and 4750A emission was accomplished with Corning filters 9863 and 3389. At room temperature, the 3050A band showed a half-width of about 400A and a long wavelength tail which extended to 4200A, but only 1% of the emission was beyond 3800A. The 4750A band typically exhibited 1/3 the peak intensity of the 3050A emission with a half-width of 1200A at room temperature. The crystal, installed in a pressure vessel with quartz optics, was stimulated with an Ir^{192} gamma ray source in a W alloy collimator. Light emission was measured with a cooled-type photomultiplier tube driving a standard electrometer circuit and equipped with a sodium salicylate wavelength shifter. The band intensity ratio of 4750A emission to 3050A emission was not affected by pressure. At 19° and 9.5°, the factor changes in emission intensity of the 4750A band relative to the 3050A band for 40,000 psi were 0.96 and 0.98. At 0°C the values were 1.04, 1.07, and 1.05, respectively. The small systematic change with temperature may be the result of excitation of trapping states which fed the emitting states under observation. (Contractor's abstract)

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Illinois Inst. of Tech. Armour Research Foundation,
Chicago.

SODIUM OZONIDE, by I. J. Solomon and A. J. Kacmarck.
[1959] [5]p. incl. disgr. (AFOSR-TN-59-742) (AF 49-
(638)618) AD 235638 Unclassified

Also published in Jour. Phys. Chem., v. 64: 168-169,
Jan. 1960.

Spectrophotometric studies indicate that Na ozonide is
formed easily at -60° by reaction of NaOH with O₃. The
ozonide also forms at 25° but decomposes rapidly. Dif-
fuse reflectance measurements on the Na ozonide
formed at 25° show a broad peak at approximately 450
mμ, although no ozonide can be extracted.

666

Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

THE VINYL CARBANION, by S. I. Miller and W. G.
Lee. Apr. 1959 [27]p. incl. diagrs. tables, refs. (Tech-
nical rept. no. 1) (AFOSR-TN-59-147) (AF 49(638)39)
AD 210981; PB 142432 Unclassified

Abstract published in 135th meeting of the Amer.
Chem. Soc. Abstracts of Papers, Boston, Mass., Apr.
5-10, 1959, p. 9-R.

Also published in Jour. Amer. Chem. Soc., v. 81: 6313-
6319, Dec. 5, 1959.

There is essentially no isotope rate effect in the de-
hydrobromination by methoxide of protonated and
deuterated *cis*-dibromoethene in methanol; under the
same conditions hydrogen exchange with the solvent ap-
pears to be ca. 25 times faster than elimination at 26°. While methyl acrylate, maleic anhydride, ethyl cin-
namate, methyl chloromaleate, 1,1-diphenylethene, tri-
phenylethene, *cis*- and *trans*-stilbene do not exchange,
cis- and *trans*-dichloroethene, *cis*- and *trans*-dibromo-
ethene, *trans*-diiodoethene, tribromoethene, and ω-
bromostyrene exchange protons for deuterium in basic
deuterium oxide. Upper limits to the pK's of the 1,
2-dihaloethenes are in the range 34-36. Lower limits
to the activation energy for isomerization of vinyl
carbanions formed from 1,2-dihaloethenes lie in the
range 25-35 kcal/mol. In the light of these observations,
a general mechanism of elimination reactions is pro-
posed. (Contractor's abstract)

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Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

NEW METHYL RADICAL SOURCE IN THE GAS
PHASE. MERCURY-SENSITIZED DECOMPOSITION

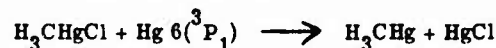
OF METHYL MERCURIC CHLORIDE (Abstract), by T.
Hirata, H. E. Gunning, and S. Sujishi. [1958] [1]p.
[AF 49(638)48] Unclassified

Presented at meeting of the Phys. and Inorg. Chem.
Div. of the Amer. Chem. Soc., San Francisco, Calif.,
Apr. 13-18, 1958.

Published in 133rd meeting of the Amer. Chem. Soc.
Abstracts of Papers, 1958, p. 2-Q - 3-Q.

A study has been made of the reaction of methyl mer-
curic chloride vapor with Hg 6(³P₁) atoms at 200°C.

The principal products of the reaction have been shown
to be calomel, ethane, and methane, with smaller
amounts of higher hydrocarbons. The data are consist-
ent with a primary process:



with the H₃CHg radicals decomposing into methyl radi-
cals. The reaction is therefore a potential source for
methyl radicals for free radical kinetic studies.

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Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

PHOTOCHEMICAL SYNTHESIS OF ENERGY RICH-
COMPOUNDS, by S. Sujishi and T. Hirata. Final rept.
Feb. 1, 1957-Aug. 31, 1958. Oct. 24, 1958 [67]p. incl.
diagrs. tables, refs. (AFOSR-TR-59-7) (AF 49(638)48)
AD 209160 Unclassified

The mercury photosensitized reaction of methylmercuric
chloride was investigated. Methylmercuric chloride was
prepared by neutralizing methylmercuric hydroxide which
was obtained by adding alcoholic KOH to methylmercuric
bromide. The melting point and the vapor pressure above
room temperature were determined for methylmercuric
chloride. Samples of methylmercuric chloride were
thermally decomposed at various temperatures; up to
200°C, there was no noticeable thermal decomposition.
Gaseous products were detected in a 90-min run at 236°
C but were insufficient for analysis. Mass spectrometric
data were obtained for the yields from a thermal decom-
position reaction which was run at 260°C for more than
30 hr; the molar percentages were 67.3% H₃CCl, 16.5%
CH₄, 7.7% C₂H₆, 2.1% H₂, and 1.0% C₃H₈. A photolysis
reaction of methylmercuric chloride was considered
negligible as compared with a sensitized reaction where
substrate decomposition attained high values within 30
min. The presence of Hg during irradiation increased
the quantity of products markedly as compared with the
thermal and photolytic reactions. X-ray analyses of the
solid products indicated only unreacted methylmercuric
chloride and mercurous chloride. No higher alkylmer-
curic chlorides, such as ethylmercuric chloride, were
encountered in the products. No evidence was obtained
for a chain reaction.

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Illinois Inst. of Tech. Dept. of Chemistry, Chicago.

THE CHEMISTRY OF SILICON AND GERMANIUM HYDRIDES, by S. Fujishi. Final rept. Feb. 1, 1958-Aug. 31, 1959, 111p. incl. diagrs. tables, refs. (AFOSR-TR-59-137) (AF 49(638)276) AD 225925; PB 143572
Unclassified

The reactions of silyldimethylamine, methyldisilylamine, and trisilylamine were studied with the strong Lewis acids diborane, trimethylaluminum, and trimethylgallium. With diborane, the formation of silyldimethylamine-borane and methyldisilylamine-borane was indicated but irreversible decomposition occurred at 0°C. With trimethylaluminum all 3 of the silylamines formed 1:1 compounds, but irreversible decomposition which led to the formation of silane was observed at or near the melting points of the addition compounds. At -78°, silyldimethylamine-trimethylgallium, and methyldisilylamine-trimethylgallium could be isolated; at or near their melting points, these compounds also decomposed to form silane. Vapor pressure data were obtained for silyldimethylamine-trimethylgallium, methyldisilylamine-trimethylgallium, and silyldimethylamine-trimethylaluminum systems. Qualitative measures were used to deduce the relative basicities of the methyl and silylamines. A value of 11.1 kcal/mol was estimated for the gas phase heat of dissociation of methyldisilylamine-trimethylgallium. The existence of the 1:1 complex, disiloxane-trimethylgallium was indicated at -78.5°.

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Illinois Inst. of Tech. Dept. of Metallurgical Engineering, Chicago.

AN INVESTIGATION OF FATIGUE PHENOMENA IN METALS BY MEANS OF A RECRYSTALLIZATION TECHNIQUE, by J. L. Peterson and N. H. Polakowski. Final rept. Apr. 1959 [65]p. incl. illus. diagrs. (Technical rept. no. 1) (AFOSR-TR-59-91) (AF 18(603)68) AD 220924; PB 143621
Unclassified

Experiments were conducted to determine the effect of combined static cold working and fatigue on the recrystallization behavior of several polycrystalline metals as indicated by the annealed grain size. The relationship between the annealed grain size and unidirectional deformation was reaffirmed and the critical deformation to initiate recrystallization was determined. The most pronounced changes were observed in annealed metals and especially in low carbon steel. Metals deformed more than the initial amount for recrystallization were softened under the action of cyclic strain to hardness levels corresponding to deformations less than the critical amount required for recrystallization. However, recrystallization could not be suppressed in this manner. A substructure hypothesis was utilized to explain the property changes resulting from the fatigue of cold worked metals. A hypothesis based on pos-

sible polygonization and sub-structure formation in statically deformed metals under cyclic stress was advanced to account for the different effects of fatigue softening on mechanical properties on one hand and the recrystallization capacity on the other. (Contractor's abstract)

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Illinois Inst. of Tech. [Dept. of Metallurgical Engineering] Chicago.

X-RAY INVESTIGATION OF IMPERFECTIONS IN SILICON SINGLE-CRYSTALS (Abstract), by L. V. Azároff and R. H. Bragg. [1959] [1]p. (AF 49(638)425)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 171, Mar. 30, 1959.

The determination of dislocation densities in single crystals using an extension of the Guinier-Tennevin transmission arrangement has been reported previously. It since has been found that significant results can be obtained only if x-radiations having wavelengths shorter than 0.70A are employed in such investigations. This is consistent with the earlier results of Allison and Parratt who observed that diffraction intensities from freshly cleaved calcite crystals agreed with calculations based on the ideally perfect crystal for $\lambda > 0.70A$ but not for shorter wavelengths. A possible reason for this is the dependence of extinction on wavelength. It can be shown that the geometry of the diffraction arrangement does not impose stringent restrictions on the thickness of the crystal used so that the bulk rather than the surface of a crystal can be investigated. Variations in the dislocation density from 10^6 to 10^8 cm^{-2} have been observed in regions of the same silicon crystal separated by only a few millimeters. These results are in accord with lifetime and noise measurements made on the same crystals. It has also been found that commercial x-ray tubes and diffractometers, with minor modifications, can be used to obtain quantitative results.

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Illinois State Geological Survey. [Div. of Fluorine Chemistry] Urbana.

[AROMATIC FLUORINE COMPOUNDS] by G. C. Finger. Final rept. Sept. 1, 1954-Sept. 30, 1958. Dec. 29, 1958, 2p. (AFOSR-TR-59-3) (AF 18(600)985) AD 261860
Unclassified

Many aromatic fluorine compounds can now be synthesized by an aryl Cl-KF exchange reaction. The development of this exchange reaction involved studies on (1) the activation of halogen atoms in aromatic systems,

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(2) the use of organic solvents, especially dimethyl formamide and dimethyl sulfoxide, in the exchange reaction, (3) the mechanics of the reaction and (4) factors governing the choice of metallic fluoride. Publications and lectures summarizing the results of this program are given. (Contractor's abstract)

673

Illinois U. Coordinated Science Lab., Urbana.

CAREFUL. A PILOT STUDY OF THE EFFECTS OF HEAVY TARGET LOAD ON HUMAN AND AUTOMATIC DECISION MAKERS, by E. W. Sinaiko and G. P. Cartwright. Sept. 1959, 35p. incl. illus. tables. (Rept. no. R-113) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-56695) AD 228109

Unclassified

A test was made of the hypothesis that heavy target loads would adversely affect a human tactical decision-maker while the same number of targets would not degrade the performance of an automatic system. A series of air defense exercises were conducted using the Cornfield system. Three levels of automaticity were introduced: (1) the system was programmed to run without any human intervention; (2) the fully automatic system had a CIC officer who could override computer decisions or make his own decisions if he chose to do so; and (3) a CIC officer had to make all decisions regarding threat evaluation and selection and assignment of weapons while the computers did only routine vectoring of interceptors. Results of the experiment did not support the hypothesis. Actually the more automatic versions of the system allowed more target penetrations and accomplished fewer kills than the least automatic mode. The results seemed to underscore the greater flexibility of the man who, in a close race, might tend to keep up the chase even though the probability of a successful kill was low. As the CIC officer gained experience and familiarity with the system he took more and more of the decision function from the computers. The ratio of target assignments to kills was lowest for the human system. (Contractor's abstract)

674

Illinois U. [Dept. of Chemistry] Urbana.

ELECTRODEPOSITION OF RARE-EARTH METALS FROM AQUEOUS AND NON-AQUEOUS SOLUTIONS, by T. Moeller, P. A. Zimmerman and others. July 31, 1959, 24p. incl. tables, refs. (AFOSR-TR-59-75) (AF 18(600)1535) AD 220100

Unclassified

Presented at Symposium on Rare-Earth Metals, Amer. Inst. Mining, Metallurgical, and Petroleum Engineers, San Francisco, Calif., Feb. 18, 1959.

Electrodeposition of the rare-earth metals is possible

in aqueous systems only with cathodes of very high hydrogen overvoltage (e.g., amalgams). Non-aqueous protonic solvents that are basic and combine the properties of high dielectric constant, low viscosity, and high heat of vaporization offer better possibilities. Many such solvents dissolve anhydrous rare-earth metal salts, but the resulting solutions show weak-electrolyte behaviors. Electrolysis never yields more than small quantities of the metals unless mercury is the cathode. (Contractor's abstract)

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Illinois U. [Dept. of Chemistry] Urbana.

RESEARCH ON CHEMISTRY AND ELECTROCHEMISTRY OF RARE-EARTH METAL SALTS IN BASIC SOLVENTS, by T. Moeller, G. W. Cullen and others. Final rept. Feb. 1, 1956-Apr. 30, 1959. June 15, 1959, 73p. incl. diagrs. tables, refs. (AFOSR-TR-59-98) (AF 18(600)1535) AD 218112; PB 142305

Unclassified

The reaction between anhydrous NdCl_3 and anhydrous $\text{Na}(\text{CNS})$ in DMF was studied conductometrically. The degree of dissociation of the electrolytes varied at different concentrations. Difficulties occurred in attempting to isolate $\text{Nd}(\text{CNS})_3$ in solid form from the DMF solution. The reaction was conducted in anhydrous EtOH at room temperature. Solvents such as tetrahydrofuran, benzene, and cyclohexane failed to precipitate $\text{Nd}(\text{CNS})_3$ from either the DMF or EtOH solutions. After the removal of NaCl, the filtrate was evaporated, and a powder-like pinkish-colored compound appeared, analyzed closely to $\text{Nd}(\text{CNS})_3 \cdot 2\text{C}_2\text{H}_5\text{OH}$. Metathetical reaction studies showed that NdCl_3 and $\text{Na}(\text{CNS})$ do not react in stoichiometric ratio of 1:6. With an azeotropic distillation technique, rare earth acetates can be dehydrated in a DMF medium; the water can be removed by benzene. Compounds were prepared of the type $\text{Ln}(\text{OAc})_3 \cdot \text{DMF}$ (where $\text{Ln} = \text{Ce}^{\text{III}}$, Pr, Nd, Sm, Eu, and Gd) and $\text{Ln}(\text{OAc})_3$ (where $\text{Ln} = \text{Dy}(\text{?})$, Ho(?), Er, Yb, Y, and La). The solvated rare-earth acetates, except Gd, melt over a small temperature range. However, the compounds lose the DMF of solvation at higher temperatures than the melting points, the desolvation being completed at about 200°C. X-ray diffraction patterns of the hydrated and dehydrated compounds were studied; the d-spacings, which were calculated from the patterns, showed differences between the 2 compounds.

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Illinois U. [Dept. of Chemistry] Urbana.

OBSERVATION ON THE RARE EARTHS. LXIX. AN ELECTROCHEMICAL INVESTIGATION OF ETHYLENEDIAMINE SOLUTIONS OF LANTHANUM NITRATE,

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by T. Moeller and G. W. Cullen. [1959] [6]p. incl. illus. diagrs. tables, refs. (AF 18(600)1535) AD 221227
Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 10: 148-152, Apr. 1959.

The solubility of anhydrous lanthanum nitrate in ethylenediamine is markedly dependent upon the water content of the latter. Conductance data for both completely anhydrous solutions and those containing controlled quantities of water show generalized weak electrolyte behavior. Electrolyses of such solutions yield cathode deposits that apparently contain small quantities of elemental lanthanum. X-ray characterization of such deposits is negated by oxide absorption of radiation diffracted by the metal. Some of the techniques essential to handling materials under anhydrous conditions are described. (Contractor's abstract)

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Illinois U. Dept. of Chemistry, Urbana.

PRECISION NULL-POINT ATOMIC ABSORPTION SPECTRO-CHEMICAL ANALYSIS, by H. V. Malmstadt and W. E. Chambers. [1959] [8]p. incl. diagrs. tables, refs. (AFOSR-TN-59-986) (AF 18(603)137)
Unclassified

Also published in Anal. Chem., v. 32: 225-232, Feb. 1960.

A new type of atomic absorptiometer is described for the sensitive and accurate quantitative determination of certain elements, such as sodium and potassium. The concentration of each sought-for element in an unknown solution is duplicated in a reference solution by an instrument which functions as a sensitive and specific null-point detector. The use of a null-point technique in conjunction with atomic absorption provides several advantages compared to measurement of absolute absorbance values. It enables exceptional precision, accuracy, sensitivity, and selectivity to be obtained with a low-cost instrument, provides self-standardization for each sample, and eliminates the need for linear response characteristics or working curves. Sodium and potassium were determined in the 1- to 100-ppm range with coefficients of variation of 0.1 to 0.3% in some cases and about 0.5% in most cases. Relative errors were the same order of magnitude as the precision. (Contractor's abstract)

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Illinois U. Dept. of Clinical Science, Chicago.

CHOLESTEROL METABOLISM, by A. C. Ivy. Final rept. Aug. 15, 1957-Jan. 14, 1958. July 1, 1959 [57]p. incl. diagrs. tables, refs. (AFOSR-TR-59-79) (AF 49-(638)242) AD 219391; PB 143736
Unclassified

Chemical analysis of the blood serum for cholesterol, and of the liver and arteries for cholesterol and total lipids were made on 638 1-wk old chicks fed for 12 wk a basal diet (B.D.) containing 23% protein, 3% fat and 0.5% cholesterol and a control group fed the B.D. only. The arteries were graded for the severity of macroscopic atheromatosis. Soya and safflower oil and tallow enhanced the hypercholesterolemic and atherogenic effects of cholesterol while stearic and palmitic acid slightly decreased these effects. Tallow fed alone and in the cholesterol diet caused a slight but significant rise in the former case and an even larger increase in the latter case. Intestinal capacity is apparently reached when the diet cholesterol is greater than 1% by weight. A 0.25% level is enough to cause an accumulation in the liver, blood serum and arteries. Correlations are made between diet cholesterol % and accumulation in humans. Heavy cholesterol feeding seems to elicit an adaptation to this diet but no mechanism is proposed.

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[Illinois U. Dept. of Mathematics, Urbana].

DEFORMATION AND MAPPING THEOREMS, by D. G. Bourgin. [1959] [19]p. incl. refs. (AF 18(603)32)
Unclassified

Published in Fundamenta Math. (Poland), v. 46: 285-303, 1959.

It is shown that a class of theorems, (Q), characterized in a general way as asserting that in the deformation of a manifold, M, a point set, P, satisfying a certain property, contains an element for which a prescribed real valued continuous function f taking on an assigned value, may be valid without (T), that is P contains a continuum joining points with $t = 0$ and those with $t = 1$. This can be done by replacing circles with n spheres, and without establishing (T), showing that there are $n + 1$ orthogonal points on intersection, for some t, of the fixed unit sphere with the deformed sphere corresponding to this t value. In connection with this, it is also shown that a general criterion for the existence of a common image point for the map of orthogonal k tuples of S^{n-1} to E^1 , yielding the first general breakthrough on a problem of Knaster's and as a special case, for n a prime, the generalized Kakutani theorem.

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THE KINETICS OF FORMATION OF A METASTABLE PHASE IN NON-EQUILIBRIUM SOLID SOLUTIONS OF GOLD AND NICKEL, by J. Cost. [1959] [48]p. incl. diagrs. refs. (AFOSR-TN-59-56) (AF 18(603)22) AD 209427; PB 139829
Unclassified

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Solid solutions of Au and Ni are being investigated to determine the deviation of the solid solution from randomness, i.e., clustering of like atoms. The effects of various heat treatments were studied on the hardness and internal friction of the Au-Ni alloy. After quenching from 850°C, an alloy containing 15% Ni showed the largest increase in hardness; this hardness effect decreased as the Ni content increased to 50% when the effect was lost. For an alloy containing 30% Ni, the hardness increase phenomenon decreased rapidly for aging temperatures above 150°C. The effect of quenching rate was measured on 30% Ni specimens quenched from 850°C and annealed at 150°C. Vacuum quench gave a cooling rate of about 6°C/sec; the cooling rate for cold water quench is unknown but was considerably greater than that for oil quench, about 150°C/sec. Data on the change of hardness during a 150°C anneal for the same alloy quenched in oil from 675°, 850°, and 925°C indicated that the quench which presumably freezes in the smallest concentration of vacancies produces the greatest hardening. Internal friction was determined at 0.6 c for specimens of the 30% Ni alloy quenched from various temperatures and rapidly brought to an appropriate annealing temperature. Internal friction decreased with time during annealing from 250°C. An as-quenched specimen showed only one peak which was at 275°C whereas the annealed specimen had a peak at 375°C.

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THEORY OF DISLOCATION CLIMB [I], by R. Thomson. Feb. 1959, 1v. incl. diagrs. refs. (AFOSR-TN-59-58) (AF 49(638)420) AD 209429; PB 138701 Unclassified

A model is constructed which describes the climb of edge dislocations in terms of the nucleation of new jogs from vacancy aggregates on the dislocations. It is shown that the climb of split dislocations can be described in terms of the same nucleation and growth phenomena as those which cause the simple edge to climb. The only difference is the size of the vacancy aggregate for which the jogs are well formed. It is suggested that small numbers of impurities should play only a minor role in jog nucleation, but should be concentrated at the nodal points of the network by the climb process. However, it seems that at low temperatures, the nodal points of a dislocation network become very efficient jog sources. It is suggested that for a simple screw dislocation, the climb process may be quite different from that for the edge dislocations, due to the possibility that the jogs on screw dislocations are non-localized. One of the parameters of our theory is the motion energy of a vacancy on the dislocation line, and an attempt is made to interpret the pipe diffusion experiments to obtain the vacancy mobility. The pipe diffusion discussion leads to a prediction that there is a considerable volume-wise relaxation in the core of the dislocation. The estimated volume change in copper

due to core relaxation is of the order of $1/2$ at vol/atom length of the dislocation line. (Contractor's abstract)

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

THEORY OF DISLOCATION CLIMB [II], by R. Thomson. Feb. 1959, 17p. incl. diagr. (AFOSR-TN-59-59) (AF 49(638)420) AD 209430; PB 138706

Unclassified

A simplified model is constructed for a climbing edge dislocation in a crystal in equilibrium with a flux of vacancies from the lattice. The climb of the model can be completely solved in terms of the build-up of vacancy aggregates on the line. Two interesting ranges of solution exist, that corresponding to a finite supersaturation and that corresponding to quasi-equilibrium. Under the quench condition, the dislocation is able to absorb all the incident vacancies with only minor perturbations due to the nucleation of new jogs. In the anneal condition, the rate of climb is very sensitive to the energy of a nucleated jog, and only slow climb is predicted for dislocations like those of copper and gold where the jog energy is high. (Contractor's abstract)

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

SOME PROPERTIES OF VANADIUM AT SUBATMOSPHERIC TEMPERATURES, by J. A. Hren, C. M. Wayman, and T. A. Read. Sept. 15, 1959 [8]p. incl. diagrs. (AFOSR-TN-59-1003) (AF 49(638)420) AD 227357; PB 149278

Unclassified

Also published in Trans. Metall. Soc. AIME, v. 218: 377-379, Apr. 1960.

The nature of the resistivity-temperature relation and the proposed allotropy in V was investigated. Resistivity measurements were made on Ca-reduced V of 99.7% purity. The specimen and thermocouple were immersed in a Dewar vessel containing isopentane. A constant temperature was maintained for more than sufficient time to make the necessary measurements. Resistance measurements were made on specimens in the annealed, vacuum-degassed, and cold-worked condition. The results showed no indication of any sudden discontinuity; however, a deviation from linearity existed at about 200°K. The measurements on heating and cooling were in agreement. The dynamic Young's modulus was measured as a function of temperature for polycrystalline specimens of 99.7% purity. No discernible deviation from linearity was apparent. X-ray diffraction studies were conducted through the same temperature range. Results indicated that the suggested allotropy in V appears to be doubtful, at least in the temperature range examined. (ASTIA abstract)

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Illinois U. Dept. of Mining and Metallurgical Engineering, Urbana.

RADIATION LIMITED DISLOCATION MOTION IN CRYSTALS, by R. Thomson. [1959] [1]p. (AFOSR-TN-59-1097) [AF 49(638)420] Unclassified

Published in Jour. Appl. Phys., v. 31: 617, Mar. 1960.

Thermal activation of dislocations across the Peierls energy barriers in crystals is discussed. Of particular interest here is the case of nearly zero average velocity while assuming that the external stress is smaller than the Peierls stress. It is assumed that the dislocation starts at the top of a Peierls hill and accelerates to the bottom due to the gain in self energy. The result is that in crystals with large Peierls energy, the observed critical shear stress where the dislocations become mobile cannot be due to a dynamic motion of the dislocation, but the dislocations must be thermally activated through the lattice hill-valley structure.

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Illinois U. Dept. of Physics, Urbana.

EXCITON STATES IN IONIC CRYSTALS, by R. S. Knox and N. Inchauspé. June 1959 [23]p. incl. diagr. table, refs. (AFOSR-TN-59-556) (AF 18(600)662) AD 216751; PB 143004 Unclassified

Abstract published in Proc. 1959 Internat'l. Symposium on Color Centers in Alkali Halides, Oregon State Coll., Corvallis (Sept. 8-11, 1959) [Salem, Oregon State Board of Higher Education] 1959, p. 21.

Also published in Phys. Rev., v. 116: 1093-1099, Dec. 1, 1959.

Exciton states in ionic crystals are analyzed according to configurations allowed by cubic point symmetry. The "excitation" and "electron transfer" models of the exciton structure are re-introduced as 2 slightly different aspects of the same general group-theoretical problem. Predictions of these models concerning multiplicity of absorption peaks are shown to be essentially identical. A theory of the "halogen atom doublet" appearing in the experimental absorption spectra of certain alkali halide crystals is given and is used in a preliminary interpretation of the electronic structure of low-lying exciton states in these solids. (Contractor's abstract)

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Illinois U. Dept. of Physics, Urbana.

PHOTOCONDUCTIVE HALL EFFECT IN SILVER BROMIDE, by D. C. Burnham. June 1959 [217]p. incl. diagr. tables, refs. (AFOSR-TN-59-717) (AF 18(600)-662) AD 226402; PB 143598 Unclassified

The Hall mobility of electronic carriers in silver bromide was investigated in the low-temperature range. The sign of the dominant carrier is negative, and the Hall mobility of electrons varies from $150 \text{ cm}^2/\text{volt-sec}$ at 125°K to about $29,000 \text{ cm}^2/\text{volt-sec}$ at 6°K . The temperature dependence of the mobility seems to be intrinsic above about 33°K and agrees with that predicted by scattering due to optical and acoustic modes of lattice vibration. Optical modes are dominant at temperatures above 40°K , and the Debye temperature associated with these modes is $195^\circ \pm 15^\circ\text{K}$. Acoustic scattering apparently is dominant between 35° and 15°K . Some type of impurity scattering has an effect below 33°K ; plausibility arguments and agreement with data indicate that this scattering may be due to ionized impurities. At temperatures above 19°K the effects of high magnetic fields are in agreement with a semi-classical theory which assumes isotropic scattering and a spherical energy-band structure. (Contractor's abstract)

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Illinois U. Dept. of Physics, Urbana.

EXPERIMENTAL RESEARCH UPON THE ELECTRONIC PROPERTIES OF NON-METALLIC CRYSTALS. Final rept. Dec. 1959 [12]p. incl. refs. (AFOSR-TR-59-196) (AF 18(600)662) Unclassified

This final report summarizes briefly the history and achievements of the research conducted under this contract. The technical reports and publications issued are listed.

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Illinois U. Dept. of Physics, Urbana.

CONFIGURATION INTERACTION IN ALKALI HALIDE PHOSPHORS, by R. S. Knox. Feb. 15, 1959 [59]p. incl. diagr. tables, refs. (AFOSR-TN-59-232) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)689 and Office of Naval Research under Nonr-183412) AD 211647; PB 144892 Unclassified

Presented at meeting of the Amer. Phys. Soc., Chicago, Ill., Nov. 28-29, 1958.

Abstract published in Bull. Amer. Phys. Soc., v. 3: 358, Nov. 28, 1958.

Also published in Phys. Rev., v. 115: 1095-1106, Sept. 1, 1959.

It is shown that excited state wave functions of free activator ions do not provide a completely adequate basis for a quantitative theory of the luminescence of alkali halides activated by heavy metals. It is proposed that better zero-order wave functions may be obtained by allowing interaction between different types of states of excitation, and as a practical example of an electronic

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configuration which can interact with excited activator configurations, the electron transfer states of the Seitz model are discussed in detail. These states have generally been ruled out because of the absence of a halogen-like doublet in the phosphor absorption spectra, but a closer analysis shows that the doublet character of the activator atom is of equal importance. Neither of the doublets is expected to appear explicitly in the spectra. A numerical estimate of the coupling between an excited activator 6s6p state and a typical electron transfer state indicates the possibility of strong interaction between these configurations. It is concluded that the Seitz model is capable of explaining recent experiments on excitation bands, polarization effects, and lattice structure dependence of absorption spectra, provided that more emphasis is placed on electron-transfer states or other excited states of the host crystal which can interact with excited activator configurations. (Contractor's abstract)

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Illinois U. [Dept. of Physics] Urbana.

THE SELF ENERGY OF A HELICAL DISLOCATION, by R. de Wit. [1959] 22p. incl. refs. (AFOSR-TN-59-555) [AF 18(600)689] AD 216720 Unclassified

Also published in Phys. Rev., v. 116: 592-597, Nov. 1, 1959.

Kröner's energy expression is used in this theoretical calculation. The helical dislocation is assumed to have a uniform shape with the Burgers vector along its axis. The axial length of the helix is large compared to its radius and the radius is large compared to the dislocation "cross section", which is of the order of a Burgers vector. For a helix of many turns and arbitrary pitch an expansion in a Fourier cosine series is used. The self energy is found in terms of elementary functions and Kapteyn series of Bessel functions. In the limiting cases of a tightly wound helix (small pitch) and a nearly straight helix (large pitch) simple expressions result, which have a plausible physical explanation. For a tightly wound helix the dominant term represents the contribution from the cylindrical part of the helix, the first-order terms represent the influence of the size of the dislocation cross section and the second order terms represent the effect of the axial component of the helix. For the nearly straight helix the dominant terms represent the contribution from the straight screw part and the second-order terms are taken to give the interaction between the turns of the helix. Finally the correction in the self-energy when a return loop is present is considered. (Contractor's abstract)

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Illinois U. Dept. of Physics, Urbana.

THEORETICAL STUDY OF THE PROPERTIES OF INSULATING AND CONDUCTING SOLIDS, by F.

Seitz. Final rept. Dec. 1, 1958-May 31, 1959. June 15, 1959, 7p. (AF 18(600)689) Unclassified

A report of the progress made to date on various aspects of this study is made. Subjects discussed include the electronic structure of the V_k center, exchange polarization in atoms and paramagnetic ions, and nuclear magnetic shielding of H^1 and F^{19} nuclei in the HF molecule. Visiting consultants, who have published work under this contract, are listed and a brief review of the work done by those individuals permanently assigned to this project is made.

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Illinois U. Dept. of Physics, Urbana.

NUCLEAR QUADRUPOLE INTERACTIONS IN ALKALI HALIDE MOLECULES, by T. P. Das and M. Karplus. [1959] [2]p. [AF 18(600)689] Unclassified

Published in Jour. Chem. Phys., v. 30: 848-849, Mar. 1959.

Theoretical values of the nuclear quadrupole coupling constants e^2qQ for both nuclei in KCl, KBr, and RbCl are compared with experimental data. It is shown that the comparison improves if the effects of the induced dipole moments on neighboring ions are taken into account and the distance R for each molecule is taken as the value obtained from molecular beam work instead of the considerably larger value obtained from the sum of the ionic radii. In the comparison of experimental and theoretical figures for the negative ion nuclei, the theory apparently collapses for the signs are of the wrong value. It is believed that the electronic contribution to the e^2qQ can account for the discrepancy.

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Illinois U. Dept. of Physics, Urbana.

THEORY OF NUCLEAR QUADRUPOLE INTERACTION IN BERYLLIUM METAL, by M. Pomerantz and T. P. Das. [1959] [9]p. incl. diagrs. refs. (In cooperation with California U., Berkeley AF 18(603)46) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(600)689] and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 251, Apr. 30, 1959. (Title varies)

Published in Phys. Rev., v. 119: 70-78, July 1, 1960.

See item no. 189 for abstract.

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Illinois U. Dept. of Physics, Urbana.

MAGNETIC PROPERTIES OF WATER MOLECULE, by T. P. Das and T. Ghose. [1959] [11]p. incl. diagr. tables, refs. [AF 18(600)689] Unclassified

Published in Jour. Chem. Phys., v. 31: 42-52, July 1959.

The mass susceptibility χ and proton magnetic shielding factor σ for H_2O molecule are calculated using a localized electron pair LCAO MO wave function. The paramagnetic part of the susceptibility and a portion of the paramagnetic part of σ are calculated by a variational method used earlier for the H_2 molecule. The calculated value of χ is found to be -0.687×10^{-6} in very good agreement with the experimental value of -0.699×10^{-6} . The calculated value of σ is, however, found to be only -0.85×10^{-5} in rather poor agreement with the experimental value of -2.97×10^{-5} . The causes for this poor agreement are analyzed, and it is concluded that the main reasons are (1) use of a rather large ionic character (66%) for the OH bond obtained from a curve of electronegativity difference versus ionic character and (2) use of undistorted H-atom orbitals in the LCAO MO function. It is suggested that the calculated value of σ would improve in the right direction if the effective charge for the H-atom orbital were taken as greater than unity. The value of σ is recalculated with Ellison and Shull's "approximate treatment" wave function and found to be -1.31×10^{-5} . The disagreement with experiment in this case is ascribed to cause (2). (Contractor's abstract)

694

Illinois U. Dept. of Physics, Urbana.

A METHOD FOR MEASURING MAGNETIC FIELDS IN SUPERCONDUCTORS, by H. R. Lewis, J. F. Cochran and others. Nov. 1959 [16]p. incl. diagrs. refs. (AFOSR-TN-59-1154) (AF 18(603)49) AD 228738; PB 144568 Unclassified

Also published in Zeitschr. Phys., v. 158: 26-34, Jan. 1960.

Conventional experiments on the magnetic properties of bulk superconductors involve space averages over distances largely compared with the penetration depth. A nuclear technique is described which permits local measurements of the variation of the magnetic field within a bulk superconductor. The results, while insufficient for determining the internal field distribution, show the expulsion of flux from samples below the critical temperature (Meissner effect). The influence of extranuclear fields on a nuclear directional correlation forms the basis of this method. When a nucleus decays through successive emission of 2 gamma rays,

for example, the direction of the 2nd is related to that of the first. This directional correlation is due to the selection of a partially oriented sample of nuclei through the observation of the 1st gamma ray in a given direction. The angular distribution of the 2nd gamma ray is fixed to the nuclear orientation and hence, is related to the direction of the 1st gamma ray. (Contractor's abstract)

695

Illinois U. [Dept. of Physics] Urbana.

PHOTOCONDUCTIVE HALL EFFECT IN KCl, by F. C. Brown and N. Inchauspé. May 1959, 2p. (AFOSR-TN-59-553) (AF 49(638)579) AD 216728; PB 143005 Unclassified

Abstract published in Proc. Internat'l. Symposium on Color Centers in Alkali Halides, Oregon State Coll., Corvallis (Sept. 8-11, 1959), [Salem] Oregon State Board of Higher Education, 1959, p. 12.

A study is made of the Hall effect for carriers released by light over a temperature range of 4° to $114^\circ K$ in additively colored crystals of KCl, containing various concentrations of F-centers. The photoconductivity for microsecond pulses of light varies with temperature. It appears that electrons are scattered primarily by optical vibrations of the lattice at temperatures above $50^\circ K$. It is indicated that the F-centers are relatively weak scattering centers.

696

Illinois U. [Dept. of Physics] Urbana.

HALL MOBILITY OF HOLES IN AgBr, by R. C. Hanson and F. C. Brown. July 1959 [9]p. incl. diagr. table, refs. (Technical note no. 2) (AFOSR-TN-59-752) (AF 49(638)579) AD 219995 Unclassified

Also published in Jour. Appl. Phys., v. 31: 210-211, Jan. 1960.

Conflicting evidence for the mobility of holes in polar crystals such as the silver halides is reviewed. Observations of the Hall effect for added carriers indicate that the holes are responsible for the observed increase in conductivity and that the mobility of holes is much greater than the mobility of ionic defects but substantially less than the mobility of electrons in the temperature range of 25° to $150^\circ C$. The conductivity, σ , of a crystal at a given temperature was found to increase by an amount, $\Delta\sigma$, upon admitting bromine or chlorine gas. Tests made on samples of different thickness and purity indicate that the phenomena is a volume effect and that the excess conductivity disappears when the halogen is pumped off. The Hall voltage was found to be linearly dependent upon magnetic and applied electric fields and independent of frequency in the range of frequencies where the impedance of the preamplifier is much larger than the crystal impedance.

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697

Illinois U. [Dept. of Physics] Urbana.

ELECTRONIC PROCESSES IN THE SILVER HALIDES AT LOW TEMPERATURE, by F. C. Brown and K. Kobayashi. [1959] [3]p. incl. diagrs. refs. (AFOSR-3996) (AF 49(638)579) Unclassified

Presented at 1958 Internat'l. Conf. on Semiconductors, Rochester U., N. Y., Aug. 18-22, 1958.

Also published in Jour. Phys. and Chem. Solids, v. 8: 300-302, Jan. 1959.

An explanation is given as to why measurements over a wide range of temperatures by transit time techniques in the case of AgCl and AgBr do not agree with expectations. It was expected that with decreasing temperature, electron mobility would increase. However, drift mobility was reportedly found to be small at low temperatures and to have a maximum in the vicinity of 50 to 90°K. Multiple trapping effects are ascribed as the cause of the drift mobility. Scattering by imperfection, although present, is ruled out. The results are arrived at by analyzing the Hall effect which is independent of trapping effects and rise to a very high value at low temperatures. Results showing that electron mobility decreases below 35°K and is still smaller below 15°K are presented.

698

Illinois U. Dept. of Psychology, Urbana.

ISSUES IN THE USE OF AN ANALOG-DIGITAL DATA SYSTEM FOR THE MEASUREMENT OF TRACKING BEHAVIOR, by C. E. Webber and J. A. Adams. Apr. 1960, 33p. incl. diagrs. tables. (AFOSR-TN-59-528) (AF 49(638)371) AD 245064; PB 152703

Unclassified

Tracking data collected by an analog-digital data system and processed with a digital computer is recommended as a solution for certain research restraints imposed by the traditional methods of measuring tracking behavior. An experiment on system parameters performed entirely on a digital computer, evaluated sampling rate and number of digits per reading of stimulated tracking error functions for time on target measures. The Sampling Theorem recommending a sampling rate twice that of the highest component frequency in the analog signal is sound for time on target computations, but somewhat lower rates appear acceptable for many applications. Empirical tracking data obtained with an analog-digital data system is presented. (Contractor's abstract)

699

Illinois U. [Dept. of Psychology] Urbana.

HUMAN TRACKING BEHAVIOR, by J. A. Adams. [1959] [25]p. incl. diagr. table. (AFOSR-TN-59-1070) [AF 49-336]371 AD 254757 Unclassified

Also published in Psychol. Bull., v. 58: 55-79, Jan. 1961.

A critical review and analysis is presented of the research, issues, and points of view associated with human behavior in 1- and 2-dimensional tracking tasks. It is suggested that 3 fundamental topics must be given more attention before an adequate theory of tracking behavior can be formulated: (1) An attempt must be made to define the allowable variations in input, both in type and functional form, as well as the characteristics of the control system used for responding. (2) Recognition must be given to the presence and interaction of several overt and intervening response and stimulus classes, and how these factors act to determine the characteristics of the measured motor response. (3) More interest should be channeled toward multidimensional tracking tasks having 2 or more stimulus sources in the same or different sense modalities, and corresponding dimensions in the control system for response to each source.

700

Illinois U. Electrical Engineering Research Lab., Urbana.

RECTANGULAR AND CIRCULAR MILLIMETER WAVEGUIDES, by P. D. Coleman and R. C. Becker. [1959] [2]p. incl. diagrs. tables. [AF 18(603)62] Unclassified

Published in Electronics, v. 32: 50-51, May 1, 1959.

Rectangular and circular waveguides are now commercially available for the frequency range 26.5 to 350 kmc, 11.5 to 0.857-mm wavelength, covering the upper range of applicability of conventional microwave techniques. The mechanical and electrical characteristics of these waveguides are given, including the nonstandard and military types.

701

Illinois U. Electrical Engineering [Research Lab.] Urbana.

FEEDING RF POWER FROM A SELF-EXCITED, PULSED SOURCE INTO A HIGH-Q RESONANT LOAD, by H. A. Spuhler, R. J. Kenyon, and P. D. Coleman. [1959] [1]p. incl. diagr. [AF 18(603)62] Unclassified

Published in I.R.E. Trans. on Microwave Theory and Tech., v. MTT-7: 391, July 1959.

A high-power ferrite isolator system is described

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which is capable of feeding 78% of the available power from a 5586, S-band megawatt magnetron into a microwave cavity having an unloaded Q of 14,400. The performance of this ferrite system is compared to the series tee and shown to result in 38% increase in power with no reduction in stability characteristics.

702

Illinois U. [Electrical Engineering Research Lab.] Urbana.

DIPOLAR MAGNETODYNAMIC FERRITE MODES, by W. H. Steier and P. D. Coleman. [1959] [2]p. incl. diags. (AF 18(603)62) Unclassified

Published in Jour. Appl. Phys., v. 30: 1454-1455, Sept. 1959.

The results of an experimental and theoretical investigation of the dipolar magnetodynamic modes of a ferrite rod between 2 conducting planes are reported. It is pointed out that the metal capped ferrite rod offers advantages in coupling compared to a ferrite body in space. These modes include propagation effects and hence the ferrite can be large compared to the wavelength. These factors are pertinent in the consideration of ferrite modes for use in parametric amplifiers and frequency multipliers. A more detailed account of the same subject will be given in a later report.

703

Illinois U. Electrical Engineering Research Lab., Urbana.

LEAST-SQUARES APPROXIMATION FOR BOTH MAGNITUDE AND PHASE BY RATIONAL FUNCTIONS, by K. S. Fu. Feb. 9, 1956, 68p. incl. diags. refs. (Technical note no. 6) (AFOSR-TN-59-71) (AF 49(636)63) AD 209846; PB 140446 Unclassified

A method is presented to approximate both magnitude and phase within a given band. The specified magnitude and phase characteristics, either in the form of a function or in terms of a graphical plot, are approximated by a rational function in the sense of minimizing the least-squares error. Preassignment of pole locations and error improvement by proper selection of poles are described. The approximation method is extended to the time-domain approximation and the simplification of a transfer function by an RC (or RL) function or an all-pole function. (Contractor's abstract, modified)

704

Illinois U. Electrical Engineering Research Lab., Urbana.

A CORRELATION BETWEEN CLASSICAL AND POLE-ZERO SENSITIVITY, by J. J. Mikulski. Feb. 20, 1959, 85p. incl. diags. tables, refs. (Technical note no. 5) (AFOSR-TN-59-72) (AF 49(636)63) AD 209847; PB 140236 Unclassified

The correlation existing between the over-all sensitivity of a network or system function and sensitivities of the poles and zeros, or roots, of that function was established. Root sensitivity is extended to the case of a nonlinear dependence of the coefficients, and so introduces a concept of a second-order sensitivity that is applicable and useful in the classical sensitivity definition. The nature of the frequency dependence of the classical sensitivity is utilized to derive the root sensitivities. An extension of the sensitivity concept to multiple roots is made possible through the correlation established. All information about the multiple root sensitivity present in the classical sensitivity function is used in the correlation, and an approximation is allowed to the root variation, owing to finite future parameter changes. The theory developed is illustrated and tested by means of a set of examples obtained from the field of passive network synthesis. Study is made of the roots of a function which may appear when the parameter varies, but are not present for the nominal parameter value. A study is made of the sensitivities when n parameters are allowed to vary simultaneously, in order to practically apply the theory to network or system theory. The concept of sensitivity is introduced into the time domain.

705

Illinois U. Electrical Engineering Research Lab., Urbana.

CONTRIBUTIONS TO TRANSISTOR-RC NETWORK SYNTHESIS, by B. R. Myers. Feb. 20, 1959, 104p. incl. diags. refs. (Technical note no. 7) (AFOSR-TN-59-73) (AF 49(638)63) AD 209848; PB 140237 Unclassified

A survey was made of existing techniques and philosophies. A new, functional symbolic representation of the equivalent circuit of a junction transistor was introduced. The concept of negative impedance conversion was extended to converters with a conversion ratio of other than minus one. Methods of realizing the sub-class of RL driving-point impedance functions by transistor-RC means are discussed. Some new methods of transfer function synthesis are presented. Of these, the most significant is a method for exact synthesis of a single pair of complex poles of transmission, which utilizes only one transistor, and a simple but powerful method for unrestricted pole realization. This method was extended to the simultaneous realization of complex zeros, including zeros in the right-half plane, and unrestricted poles. Some methods of realizing non-positive real driving-point impedances are presented. (ASTIA abstract, modified)

706

Illinois U. Electrical Engineering Research Lab., Urbana.

ACTIVE NETWORK SYNTHESIS BY LATITUDE REDUCTION, by R. E. Thomas. May 15, 1959, 95p. incl. diags. tables, refs. (Technical note no. 8) (AFOSR-TN-59-584) AD 217031; PB 143515 Unclassified

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Development efforts are concerned with an active RC synthesis procedure which begins with the synthesis of a symmetric lattice. For active elements the negative impedance converter (NIC) is used exclusively. The exclusive use of the NIC is convenient since the NIC may be studied and perfected as an independent problem. That is, a function has been assigned to the active elements which is independent of the synthesis process. Due account is taken of such things as impedance levels and biasing provisions but it is seen that biasing resistance can almost always be built into the lattice in the synthesis process. The various NIC-type networks are not covered here. For these purposes the NIC is merely a 2 port device which presents a input immittance which is the negative of the load immittance. The ideal NIC behavior can be attained to a degree which is compatible with the approximations in the passive elements which will be used. In brief, as a synthesis tool the NIC is a practical device in the fullest sense of the word. (Contractor's abstract)

707

Illinois U. Electrical Engineering Research Lab., Urbana.

ON THE SYNTHESIS OF TIME VARYING LINEAR SYSTEMS, by J. B. Cruz, Jr. Aug. 7, 1959, 96p. incl. diagrs. refs. (Technical note no. 9) (AFOSR-TN-59-866) (AF 49(638)63) AD 226580; PB 144311

Unclassified

It is shown that any multi-input-multi-output linear system may always be represented by a set of single-input-single-output linear subsystems connected properly. Attention is focused on some properties of single-input-single-output linear systems which are generally time varying. These properties are exploited in developing synthesis procedures for time-varying linear systems with specifications in the time domain, frequency domain, and general λ domains. In connection with synthesis in a general λ domain, compatible systems are defined. The techniques for fixed linear systems in the frequency domain apply to compatible time-varying linear systems in an appropriate λ domain. The characterization or system functions for all the models considered belong to the class of separable functions first treated by Bendat. Necessary and sufficient conditions are derived for the exact realization of certain classes of functions. However, a much wider class of specified system functions may be expanded in terms of a set of orthogonal and realizable functions. It is well known that if the series is truncated, the approximation is best in the sense of minimum integral square error. The basic time-varying element used in most of the models is a time-varying gain amplifier. The approximation of the time-varying gain amplifier by periodically operated switches, sinusoidal time-varying amplifiers, and sequentially gated amplifiers is discussed. (Contractor's abstract)

708

Illinois U. Electrical Engineering Research Lab., Urbana.

TWO THEOREMS IN MULTI-WEIGHTED SUMS, AND THEIR APPLICATION IN THE STABILITY ANALYSIS OF ACTIVE LINEAR SYSTEMS, by B. R. Myers. Nov. 5, 1959, 17p. incl. diagrs. (Technical note no. 10) (AFOSR-TN-59-1096) (AF 49(638)63) AD 231383; PB 145558

Unclassified

The first theorem shows that the collection of all normalized, nonnegatively multiweighted sums of a finite set of vectors belonging to an arbitrary finite-dimensional vector space is contained in the convex hull of the vertex vectors of the normalized weights. The second theorem states a sufficient condition under which the collection is complete, i.e. such that there is no point in the convex hull which is not a point of the sum. Two corollaries of this theorem identify particular types of sum for which the collection is complete. Applications of the theorems in the stability analysis of active linear systems with multi-parameter variance leads to a useful graphical method which might be described as a generalization of Nyquist's criterion for stability. (Contractor's abstract)

709

Illinois U. Electrical Engineering [Research Lab.] Urbana.

DESIGN OF COMBINATIONAL SWITCHING CIRCUITS USING AN ITERATIVE CONFIGURATION, by D. L. Epley. [1959] [23]p. incl. diagrs. refs. (AFOSR-3847) [AF 49(638)63]

Unclassified

Also published in Proc. Fourth Midwest Symposium on Circuit Theory, Marquette U., Milwaukee, Wis., Dec. 1959, p. M-1 - M-23.

The design of an iterative network structure which can handle an appreciable number of variables, which contains several switching functions, and whose action can be easily described by a simple verbal statement is discussed. The overall design procedure entails 4 steps: (1) construction of a state or flow table for the typical cell, (2) assignment of carry-variables, (3) construction of a typical cell, and (4) modification of the end cells. Design examples are given.

710

Illinois U. [Electrical Engineering Research Lab.] Urbana.

AN EXTENSION OF PRONY'S METHOD TO FREQUENCY DOMAIN APPROXIMATION, by J. B. Cruz, Jr. [1959] [12]p. incl. diagr. (AFOSR-3848) [AF 49(638)63] AD 289308

Unclassified

Also published in Proc. Fourth Midwestern Symposium on Circuit Theory, Marquette U., Milwaukee, Wis., Dec. 1959, p. H-1 - H-12.

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In approximating a specified function $H(s)$ by $H^*(s)$ corresponding to a realizable network, the criterion of least integral square error in the frequency domain is intimately connected with an expansion of $H(s)$ in an orthogonal set of rational functions $\{\phi_K(s)\}$. For a

specified error tolerance, the necessary number of terms in the expansion may be large because $\{\phi_K(s)\}$

is arbitrary. In this study, the Prony method which has been originally applied to time domain approximations will be extended to frequency domain approximations, in an attempt to make the number of poles of $H^*(s)$ small. The method is to "fit" a homogeneous differential equation to the "natural" frequencies of the system. The residues at the chosen poles are then optimized in the least integral square sense on the $j\omega$ axis. An example is presented to illustrate the procedure. (Contractor's abstract)

711

Illinois U. [Electrical Engineering Research Lab.] Urbana.

RECENT ADVANCES IN ACTIVE NETWORK SYNTHESIS, by M. E. Van Valkenburg. [1959] [13]p. incl. diagrs. refs. (AFOSR-3850) [AF 49(638)63] AD 289311 Unclassified

Also published in Fourth Midwest Symposium on Circuit Theory, Marquette U., Milwaukee, Wis., Dec. 1959, p. N-1 - N-13.

There are indications that active network synthesis has come of age. In the telephone industry, for example, transistor-RC networks have only recently replaced passive LC networks in some applications. This paper outlines recent developments in realization methods and performance criteria. In particular, the work at Illinois U. is reviewed, including that of Chien, Myers, and Thomas relating to realization, and by Kuo and Mikulski on sensitivity. This work is related to the important contributions of Linvill, Yanagisawa, and Horowitz. (Contractor's abstract)

712

Illinois U. Electrical Engineering [Research Lab.] Urbana.

A GENERALIZATION OF THE IMPULSE TRAIN APPROXIMATION FOR TIME-VARYING LINEAR SYSTEM SYNTHESIS IN THE TIME DOMAIN, by J. B. Cruz, Jr. [1959] [2]p. incl. diagrs. (AFOSR-3852) (AF 49(638)63) Unclassified

Also published in I.R.E. Trans. on Circuit Theory, v. CT-6: 393-394, Dec. 1959.

A simple procedure is described for approximating the impulse response of a time-varying linear system by a series of impulse planes. A common system specification is the impulse response $h(t, \tau)$ which is the output

when the input is a unit impulse $\delta(t - \tau)$. The instant of observation is t and the impulse is at τ . The approximation and realization of a given $h(t, \tau)$ is discussed.

713

Illinois U. [Electrical Engineering Research Lab.] Urbana.

TRANSISTOR-RC NETWORK SYNTHESIS, by B. R. Myers. [1959] [10]p. incl. diagrs. refs. (AFOSR-3853) (AF 49(638)63) Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Also published in I.R.E. WESCON Convention Record, Pt. 2: 65-74, 1959.

Several methods of transfer function realization are presented. The most significant of these is a method for realizing unrestricted complex poles of transmission. The power of the method lies in its simplicity, and in the fact that the synthesis is from one end of the network, so that the synthesizer is able to maintain control over the poles of the driving-point function. The negative elements which arise are all accommodated in a single shunt branch across the output terminals, realizable by a single NIC. A simple extension of this method, utilizing topologically-generated zero-producing sections, enables the simultaneous realization of complex zeros, including zeros in the right-half plane, and unrestricted poles. Two methods for general transfer function synthesis, a method for exact realization of a single pair of poles of transmission which utilizes only one transistor, and a method for synthesizing a complex pole pair when the network terminations are specified, are also given. (Contractor's abstract)

714

Illinois U. Electrical Engineering [Research Lab.] Urbana.

WHAT IS NEGATIVE IMPEDANCE? by B. R. Myers. June 5, 1959, 2p. (AFOSR-3854) [AF 49(638)63] Unclassified

Also published in Jour. Inst. Elec. Engineers (London), v. 5: 471-472, Aug. 1959.

Comments are made on an article by M. O. Williams [Jour. Inst. Elec. Engineering (London), v. 5: 169, 1959] defining impedance as the ratio of the r.m.s. current which is produced thereby, and that it should be denoted by the symbol Z . It is pointed out in the present note that the foregoing definition is incomplete and that in steady-state analysis and cisoidal time-functions, impedance of a 2-terminal circuit is equal to the constant of proportionality which relates the cisoidal voltage drop across the 2 terminals to the cisoidal current which flows through the circuit from the terminal of

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assumed higher potential. This definition is held to be purely mathematical and negates the necessity to specify that the voltages and currents be r.m.s. quantities.

715

Illinois U. [Electrical Engineering Research Lab.] Urbana.

A USEFUL EXTENSION OF THE NYQUIST CRITERION TO STABILITY ANALYSIS OF MULTILoop FEEDBACK AMPLIFIERS, by B. R. Myers. [1959] [18]p. incl. diags. (AFOSR-3855) (AF 49(638)63) AD 289310
Unclassified

Also published in Proc. Fourth Midwest Symposium on Circuit Theory, Marquette U., Milwaukee, Wis., Dec. 1959, p. J-1 - J-18.

A simple graphical solution to the problem of examining system stability when several parameters are allowed to vary simultaneously is presented. This solution might be regarded as an extension of the Nyquist criterion in that the behavior of the characteristic equation of the system is examined along the radian frequency axis in the s -plane. The method involves plotting only a finite number of Nyquist diagrams; a system with n variable parameters requires at most $(2^n - 1)$ separate Nyquist plots, and in many practical cases less than half of this number are sufficient. The main disadvantage of the method is that it leads to a criterion which in the general case is merely sufficient. In many practical cases, however, it turns out that the criterion is both necessary and sufficient. (Contractor's abstract, in part)

716

[Illinois U. Electrical Engineering Research Lab., Urbana]

THE ACTIVE CONSTANT-RESISTANCE LATTICE, by R. E. Thomas. [1959] [11]p. incl. diags. tables. (AFOSR-3858) (AF 49(638)63) AD 289310
Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 12-14, 1959.

Also published in Proc. Nat'l. Electronics Conf., v. 15: 727-737, 1959.

A major practical difficulty associated with most methods of active RC synthesis is the difficulty of obtaining proper alignment. A useful procedure for reducing the alignment problem is cascade synthesis and one method of cascade synthesis is the constant-resistance lattice. The passive constant-resistance lattice technique is extended to active networks in which the available network elements are positive and negative resistors, and capacitors. A method is presented for synthesizing constant-resistance sections which realize a pair of restricted zeros and a pair of left-half plane poles. Three procedures are given for reducing the lattice to

an unbalanced equivalent 2-port made up of resistors, capacitors, and negative impedance converters (NIC). NIC biasing requirements are met by inserting resistance into the lattice at an appropriate stage of the decomposition process. Sensitivity properties of the active lattice are analyzed and it is shown that proper evaluation can be made only in terms of classified sensitivity since the poles of the constant-resistance lattice always have infinite root sensitivity. The procedure for controlling the sensitivity properties of the lattice is largely one of trial and error but the results are competitive with other methods of RC-NIC synthesis. Several examples of sensitivity computations are given to illustrate the theory. (Contractor's abstract)

717

Illinois U. Electrical Engineering Research Lab., Urbana.

ELECTRONIC HEATING AND BREAKDOWN OF SEMICONDUCTORS IN MICROWAVE FIELDS. AN INVESTIGATION OF MICROWAVE DUPLEXER SWITCHING MECHANISMS, by K. H. Seeger. Oct. 1, 1958, 47p. incl. diags. tables, refs. (Technical rept. no. 1) (AFOSR-TN-59-57) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-417 and Signal Corps under DA 36-039-sc-73150) AD 209428; PB 156089
Unclassified

A research program was conducted to investigate the use of semiconductors for a TR microwave switch. A semiconductor switch using germanium at liquid helium temperature was found superior to gas-filled TR tubes in respect to nondestructive breakdown. Because of the inconvenience of the low temperature, investigations were made with germanium with deep levels at liquid nitrogen temperature. In addition, with ordinary germanium of various impurity concentrations the electron energy transfer mechanism including optical and acoustical phonon scattering was studied at both high and low microwave power levels between 80°K and 300°K. Electron-electron scattering seems to dominate the energy transfer to the lattice, since the high-field mobility apparently depends on the carrier concentration. The experimental data are in agreement with those obtained by dc methods. This suggests that the relaxation time of the carriers is smaller than 5×10^{-12} sec. (Contractor's abstract)

718

Illinois U. Electrical Engineering Research Lab., Urbana.

EFFECT OF ION BOMBARDMENT ON SEMICONDUCTOR SURFACES, by S. R. Arnold. Mar. 20, 1959, 95p. incl. diags. refs. (Technical note no. 1) (AFOSR-TN-59-131) (AF 49(638)417) AD 210839; PB 139999
Unclassified

Measurements of surface properties of etched Ge

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surfaces were conducted before and after bombardments by 500- and 1000-v oxygen ions. Simultaneous photoconductance and field effect measurements were made in vacuum at a room temperature in an effort to correlate surface lattice disorder with the surface state structure. Bombardment had the general effect of increasing the surface state density without causing major changes in the trapping structure. Comparison of changes in surface recombination with changes in overall charge localized in fast states indicated that the density of the dominant recombination centers in etched surfaces may be more than an order of magnitude smaller than commonly reported. Evidence is presented to suggest that the ability of conventional field effect experiments to measure the densities of the dominant recombination centers in such surfaces may be open to question. Surface recombination velocity behavior is roughly indicative of a dominant recombination center located 5 to 6 kT above mid-gap.

719

Illinois U. Electrical Engineering Research Lab., Urbana.

THE CONDUCTANCE OF A CLEANED GERMANIUM SURFACE, by W. Portnoy and P. Handler. Mar. 20, 1959, 75p. incl. diagrs. refs. (Technical note no. 2) (AFOSR-TN-59-132) (AF 49(638)417) AD 210840; PB 139993 Unclassified

The conductivity and field effect mobility of the carriers in the region of the space charge of a cleaned germanium surface were measured as a function of various gas ambients and as a function of temperature. The carriers in the region of the space charge at a germanium surface, cleaned by argon sputtering and annealing, were p-type in character and exhibited the characteristics of a degenerate gas. Adsorption of water vapor on the surface decreased this p-type space charge region while atomic hydrogen enhanced it. Adsorption of oxygen first enhanced the p-type region and then decreased it. The p-type region arises from the nature of the germanium surface atoms. These atoms act as acceptors by trapping an electron from the bulk into their unfilled orbitals at the surface. The measurements of the excess conductivity associated with this region of space charge as a function of temperature substantiated the degeneracy of the valence band by showing only a very slight variation over the range 77° to 300°K. Rough estimates indicated that the number of holes in the region of the space charge does not change by more than a factor of two over the temperature range investigated.

720

Illinois U. Electrical Engineering Research Lab., Urbana.

EFFECT OF HEAVY DOPING ON THE DIFFUSION OF IMPURITIES IN SILICON, by M. F. Millea. July 15, 1959, 45p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-59-460) (AF 49(638)417) AD 215265; PB 143673 Unclassified

The diffusivities of P, Sb, Sn and In in "intrinsic" (10^{15} impurity atoms/cm³ or less), heavily doped n-type (5×10^{19} atoms/cm³), and heavily doped p-type (2×10^{20} atoms/cm³) silicon have been measured to obtain information on the way diffusion takes place. The measured diffusivities of P and Sb in n-type are twice their values in intrinsic silicon; their diffusivities in p-type are one half those in intrinsic silicon. These changes are in the direction expected for vacancy diffusion. The diffusivity of Sn in n-type is about 50% larger than in intrinsic, whereas in p-type it is about equal to that in intrinsic silicon. Opposite changes are found for the diffusivity of indium; it is about 6 times larger in p-type and about 50% lower in n-type than in intrinsic silicon. Possible diffusion mechanisms for substitutional impurities in silicon are discussed in the light of these and other data. (Contractor's abstract)

721

Illinois U. Electrical Engineering Research Lab., Urbana.

MICROWAVE INDUCED CARRIER MULTIPLICATION IN GERMANIUM, by K. [H.] Seeger. [1959] [2]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)417] and Signal Corps) Unclassified

Published in Jour. Appl. Phys., v. 30: 443-444, Mar. 1959.

Experiments on impact ionization in germanium using dc fields are reported. It is shown that the microwave power transmission of n-type germanium is +, at first proportional to the incident power. The data is compared to other results in the field.

722

Illinois U. Electrical Engineering Research Lab., Urbana.

MICROWAVE FIELD DEPENDENCE OF DRIFT MOBILITY IN GERMANIUM, by K. [H.] Seeger. [1959] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)417] and Signal Corps) Unclassified

Published in Phys. Rev. v. 114: 476-481, Apr. 15, 1959.

At lattice temperatures between 80 and 300°K, electrons and holes in germanium have been heated by microwaves, with an extension to high microwave fields of the technique developed by Morgan. The microwave frequency was 34.67 kmc/sec. The effect of carrier densities between 10^{13} and 10^{16} /cm³ has been investigated. At large microwave fields E (up to about 10^4 volts/cm in amplitude) the mobility μ , relative to the mobility μ_0 at zero field, is proportional to $E^{-\gamma}$; the exponent γ is

AIR FORCE SCIENTIFIC RESEARCH

smaller for purer samples. These microwave measurements agree with previous dc field measurements. At small values of E , $(\mu_0 - \mu)/\mu_0 E^2 = \alpha$ is field independent. The variation of α with lattice temperature T has been measured. In the range of pure lattice scattering, $\alpha(T) \propto \mu_0^2 T^x$; $\exp x = (n/n_0)^{0.67}$ where $n_0 = 1.7 \times 10^{14} \text{ cm}^{-3}$ for electrons and $1.0 \times 10^{14} \text{ cm}^{-3}$ for holes. This dependence on carrier density suggests that carrier-carrier interaction plays an important role in the carrier-phonon scattering mechanism. (Contractor's abstract)

723

Illinois U. [Electrical Engineering Research Lab.] Urbana.

EFFECT OF OXYGEN IN SILICON ON PHOSPHORUS DIFFUSION, by J. L. Hartke. [1959] [2]p. incl. diagr. refs. (AF 49(638)417) Unclassified

Published in Jour. Appl. Phys., v. 30: 1469-1470, Sept. 1959.

The diffusion coefficient of phosphorus in silicon was measured for silicon samples with concentrations of oxygen differing by several orders of magnitude. No variation with oxygen content was found, indicating that there was no combination of oxygen with the diffusing phosphorus.

724

Illinois U. Electrical Engineering [Research Lab.] Urbana.

A NEW LOOK AT LIGHT, by D. F. Holshouser. [1959] [11]p. incl. illus. diagrs. [AF 49(638)556] Unclassified

Also published in Bridge of Eta Kappa Nu, v. 55: 5-9, 1959.

The use of the range of visible light as a frequency to carry communications is discussed. The arguments most often presented against the potential use of light are stated. They include the following: (1) Sunlight and other sources of noise at light frequencies together with the scattering of light by the atmosphere make it extremely difficult to achieve reasonable signal-to-noise ratios in the transmission of information by light carrier. (2) Light sources are incoherent. (3) Light is difficult to amplitude modulate at high frequencies or to frequency modulate at any frequency. These arguments are discussed and ways to overcome them pointed out. The advantages of light source utilization are shown also including the fact that light has a fine modulation frequency range. The ways to modulate the light source itself are pointed out. The Kerr effect is also discussed. The problems that it creates are shown to be surmountable. It is added that the modulation at microwave frequencies is too expensive to be

more than a laboratory tool now, but the accomplishments demonstrated here do serve to note the potentialities for the use of light as a medium of communication.

725

Illinois U. Engineering Experiment Station, Urbana.

COMPRESSIBLE NON-ISOENERGETIC TWO DIMENSIONAL TURBULENT ($Pr_t = 1$) JET MIXING AT CONSTANT PRESSURE. AUXILIARY INTEGRALS HEAT TRANSFER AND FRICTION COEFFICIENTS FOR FULLY DEVELOPED MIXING PROFILES, by H. H. Korst and W. L. Chow. Jan. 1959 [12]p. incl. diagrs. (ME Technical note no. 392-4) (AFOSR-TN-59-380) (AF 18(600)392) AD 213685; PB 139c52

Unclassified

Definitions and graphical presentation of auxiliary functions, calculated on a high speed digital computer (ILLIAC), pertaining to the 2-dimensional non-isoenergetic turbulent jet mixing problem are presented. Theoretical friction coefficients and Stanton numbers for such mixing regions are given. The results especially facilitate the treatment of jet-slipstream interaction (base pressure and base temperature problem). (Contractor's abstract)

Imperial Coll. of Science and Tech. (Gt. Brit.).
see London U. Imperial Coll. of Science and Tech. (Gt. Brit.).

726

Indiana U. Dept. of Chemistry, Bloomington.

CORRELATION ENERGY IN THE HYDROGEN MOLECULE, by H. Shull. [1959] [10]p. incl. tables, refs. (AFOSR-340) (In cooperation with Uppsala U. (Sweden) AF 61(514)1200) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)318, Alfred P. Sloan Foundation, National Science Foundation, and Research Corporation) Unclassified

Also published in Ann. Acad. Regiae Scient. Upsaliensis, v. 3: 65-74, 1959.

The correlation energy of the hydrogen molecule is considered as related to the He atom and to the infinitely separated atoms, and it is shown that one can obtain a consistent qualitative picture of the electron-electron interaction in the molecular bond in this way. In particular, the molecule approaches very closely the united atom He in nature. The bond can be described as roughly 98.4% Σ_g , 1.0% Σ_u , and 0.5% π in character, with smaller amounts of higher terms. The analysis demonstrates the importance of the hitherto much neglected angular correlation terms, which will, for example, probably play an important role in the discussion of hindered rotation. Finally, it seems unlikely that the

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concepts of ionic and covalent character as usually defined have further utility in the description of the 2-electron homopolar bond. (Contractor's abstract)

727

Indiana U. Dept. of Chemistry, Bloomington.

NATURAL SPIN ORBITAL ANALYSIS OF HYDROGEN MOLECULE WAVE FUNCTIONS, by H. Shull. [1959] [9]p. incl. tables, refs. (AFOSR-341) (In cooperation with Uppsala U. (Sweden) AF 61(514)1200) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)318, Alfred P. Sloan Foundation, National Science Foundation, and Research Corporation)

Unclassified

Also published in Jour. Chem. Phys., v. 30: 1405-1413, June 1959.

Approximate wave functions for the hydrogen molecule ground state previously available in the literature are analyzed quantitatively into approximate natural spin orbital functions with particular attention to the corresponding occupation numbers. The analysis demonstrates the very great similarity of all such trial wave functions, and especially the largely molecular orbital nature of the wave function. In addition it shows a close relationship between the molecular orbital and valence bond functions, and the importance for allowing for angular correlation of the electrons by including terms dependent upon the azimuthal coordinate. The analysis particularly demonstrates that approximate natural spin orbital occupation numbers are nearly invariant under a wide variety of choices of basis functions, and therefore are particularly suitable for comparison of different approximate functions and for discussion of their respective properties. (Contractor's abstract)

728

Indiana U. Dept. of Chemistry, Bloomington.

SINGLE-CENTER WAVE FUNCTION FOR THE HYDROGEN MOLECULE, by S. Hagstrom and H. Shull. [1959] [9]p. incl. tables, refs. (AFOSR-342) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)318, Alfred P. Sloan Foundation, National Science Foundation, and Research Corporation)

Unclassified

Also published in Jour. Chem. Phys., v. 30: 1314-1322, May 1959.

The ground state of the hydrogen molecule is studied using an expansion based on a single center, the molecular midpoint, with basis orbitals constructed from associated Laguerre functions with a single orbital exponent. The convergence of the expansion is studied by systematic addition of terms and is found to be slow. The best wave functions attained have energies of -1.15086 (38 axially symmetric terms), and -1.16141

(44 terms). The results are shown to be very similar to those obtained by using Slater orbitals with nonintegral principal quantum number both from the energy increments observed and from a natural spin orbital occupation number analysis. It is concluded that the slow convergence probably results from failure to represent adequately the singularities at the nuclei, and that further use of single-center expansions in diatomic problems (except at very small internuclear distances) seems unprofitable, irrespective of what set of orbitals is used as a basis. (Contractor's abstract)

729

Institut de Recherches Scientifiques et Techniques du Centre-Ouest, Poitiers (France).

RESEARCH ON EXPERIMENTAL INVESTIGATION OF VARIABLE CIRCULATION AROUND AN ASPIRATED CYLINDER. [1959] [40]p. incl. illus. diagrs. tables. (Rept. no. E1/573) (AFOSR-TR-59-105) (AF 61(514)-1379) AD 162109; AD 225389; PB 144295

Unclassified

The conditions necessary to obtain maximum lift and lift/drag ratio were determined for a porous cylinder arranged to permit the aspiration of the surface laminar sub-layer. The method used to create a particular circulation consisted in (assuming complete suppression of the laminar layer) shifting the transition point, normally behind the cylinder, through an angle θ to the right or left. This was obtained by a deflector fin which caused flow of air away from the aspirating surface. Two variations in procedure were also studied: (1) the fin was replaced by a small arc of surface devoid of aspiration pores thus allowing the flow to separate; and (2) aspiration was provided on 1 side of the cylinder only, allowing separation flow on the other side. Two series of tests were actually run. An infinitely long cylinder was simulated by fixing vane plates of diameter triple that of the cylinder to the cylinder ends. The first series of tests was run with a cylinder 3 meters long by 0.90 m in diam, and measurements were taken of the total forces on cylinder, vane plates and deflector fin. The second series, of a more theoretical nature, was run using a cylinder 1 m in length by 0.30 m in diam., with only the forces on the cylinder being measured. The vane plates and deflection fin were independently fixed, and since they were not in contact with the cylinder, were not weighed. (Contractor's abstract)

730

[Institute for Advanced Study, Princeton, N. J.]

A SINGULAR BOUNDARY VALUE PROBLEM FOR A NON-SELF-ADJOINT DIFFERENTIAL OPERATOR, by R. R. D. Kemp. [1958] [16]p. [AF 18(600)1109]

Unclassified

Published in Canad. Jour. Math., v. 10: 447-462, 1958.

AIR FORCE SCIENTIFIC RESEARCH

The subject of this paper is the eigenfunction expansion theory associated with the operator $L = -d^2/dx^2 + g(x)$, where $g(x)$ is a complex-valued function such that $(x^2 + 1)^{1/2} |g(x)|$ is integrable over $(-\infty, \infty)$. It is found that there is a function $W(s)$, analytic for $\text{Im } s > 0$ and continuous for $\text{Im } s = 0$, such that the squares of its zeros in $\text{Im } s > 0$ constitute a bounded set which is the point spectrum of L . The continuous spectrum is the set of all real non-negative numbers. An expansion theorem is obtained by a method involving contour integration. (Math. Rev. abstract)

731

Institute for Advanced Study, Princeton, N. J.

ON $u'' + (1 + \lambda g(x))u = 0$ FOR $\int_0^\infty |g(x)| dx < \infty$, by R.

R. D. Kemp and N. Levinson. June 1959, 6p. (AFOSR-TN-59-643) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1109 and Office of Naval Research) AD 220344; PB 145297

Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 82-86, Feb. 1959.

If $g(x) \in L^1(0, \infty)$ and $u(x, \lambda)$ is the solution of $u'' + (1 + \lambda g(x))u = 0$ which satisfies the initial conditions $u(0) = 0$, $u'(0) = 1$, then there are functions $r(\lambda)$ and $\theta(\lambda)$ such that $\lim_{\lambda \rightarrow 0} \{u(x, \lambda) - r(\lambda) \sin[x + \theta(\lambda)]\} = 0$ for real

λ . It is shown that $r(\lambda)$ and $\theta(\lambda)$ are real analytic on the real axis if $g(x)$ is real, and that $r(\lambda) > 0$. The nearest singularity of r and θ to the origin is at least a distance $\log 2[\int_0^\infty |g(x)| dx]^{-1}$ from $\lambda = 0$, and the singularities are determined by the zeros of 2 entire functions. (Contractor's abstract)

732

Institute for Advanced Study, Princeton, N. J.

ANOTHER CUTPOINT THEOREM FOR PLANE CONTINUA, by F. B. Jones. Oct. 1959, 4p. (AFOSR-TN-59-1123) (AF 18(600)1109) AD 229960; PB 145485

Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 556-558, Aug. 1950.

If p and q are points of different components of the interior M , then some point x of M cuts p from q in M . In the given situation there is a point x of M which belongs to every subcontinuum of M which contains both p and q . It is not necessary that p and q belong to the same interior component if no point of M cuts between them. But it is necessary that both p and q belong to the closure of some interior component. If the closure

of no interior component of M contains both p and q , then some point x of M cuts p from q in M . (Contractor's abstract)

733

Institute for Advanced Study, Princeton, N. J.

A PLANE CONTINUUM NO TWO OF WHOSE NON-DEGENERATE SUBCONTINUA ARE HOMEOMORPHIC: AN APPLICATION OF INVERSE UNITS, by R. D. Anderson and G. Choquet. [1959] [7]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1109 and National Science Foundation)

Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 347-353, June 1959.

It is shown by constructive proof that there exists a plane continuum M such that (1) no subcontinuum of M separates the plane, (2) no 2 nondegenerate subcontinua of M are homeomorphic, and (3) M does not contain uncountably many disjoint nondegenerate subcontinua. A modification of the construction is suggested to yield a continuum M' such that (1) every nondegenerate subcontinuum of M' separates the plane, and (2) no 2 nondegenerate subcontinua of M' are homeomorphic. Further suggested modification of construction leads to a continuum M'' such that (1) no nondegenerate subcontinuum of M'' is embeddable in the plane, (2) no 2 nondegenerate subcontinua of M'' are homeomorphic, and (3) M'' does not contain uncountably many disjoint nondegenerate subcontinua. (Math. Rev. abstract)

734

Institute for Advanced Study, Princeton, N. J.

AFFINE-REGULAR POLYGONS INSCRIBED IN PLANE CONVEX SETS, by B. Grünbaum. Feb. 1959, 6p. incl. refs. (AFOSR-TN-59-207) (AF 49(638)253) AD 211661; PB 142005

Unclassified

The possibility of inscribing affine-regular polygons in nondegenerate plane convex sets is considered. Any boundary point of such a set is the vertex of an inscribed affine-regular pentagon, and there exist inscribed affine-regular pentagons having one side parallel to any given direction. An affine-regular octagon may be inscribed in any centrally symmetric convex set. (Contractor's abstract)

735

Institute for Advanced Study, Princeton, N. J.

ON INTERSECTIONS OF SIMILAR SETS, by B. Grünbaum. Mar. 1959, 15p. incl. refs. (AFOSR-TN-59-391) (AF 49(638)253) AD 214511; PB 142002

Unclassified

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Some aspects on the intersections of convex sets are discussed. To any convex compact set K , 2 numbers $h(K)$ and $H(K)$ are associated and defined as follows: $h(K)$ is the least cardinal n such that whenever a family $\kappa = \{x_\alpha + K\}$ of mutually intersecting translates of K is given, there exist n points such that each member of κ contains at least 1 of them, and $H(K)$ is the least cardinal n such that whenever a family $\kappa = \{x_\alpha + \lambda_\alpha K\}$ of mutually intersecting translates of sets homothetic to K is given, there exist n points such that each member of κ contains at least 1 of them. $H(K)$ and $h(K)$ are invariant under nonsingular affine transformations of K and remain unchanged if $K \subset E^n$ is imbedded in a space of higher dimension (E^k is the k -dimensional Euclidean space). Using this notation, the results are stated as follows: If K is a circle, then $h(K) = 3$; $h(K) = 1$ for $K \subset E^n$ if and only if K is a parallelohedron. $H(K) = 1$ also. The finiteness is established for $h_n = \max \{h(K); K \subset E^n\}$ and $H_n = \max \{H(K); K \subset E^n\}$. $H(K)$ and $h(K)$ are considered for centrally symmetric $K \subset E^2$. Some unsolved problems are discussed, and some conjectures are offered.

736

Institute for Advanced Study, Princeton, N. J.

INTRINSIC OPERATORS IN THREE-SPACE, by V. L. Shapiro. May 1959, 16p. (AFOSR-TN-59-499) (AF 49(638)253) AD 215924; PB 146213 Unclassified

Also published in Pacific Jour. Math., v. 9: 1257-1267, 1959.

The following theorem is proved: let D be a domain in Euclidean 3-space and let v be a continuous vector field defined in D . Then a necessary and sufficient condition that v be locally in D the gradient of a potential of a distribution with continuous density, is that the intrinsic curl of v be zero in D , and the intrinsic divergence of v be continuous in D .

737

Institute for Advanced Study, Princeton, N. J.

A VARIANT OF HELLY'S THEOREM, by B. Grünbaum. Sept. 1959, 9p. incl. refs. (AFOSR-TN-59-980) (AF 49(638)253) AD 228283; PB 144477 Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 517-522, Aug. 1960.

The following modification of Helly's theorem on intersections of convex sets is established, together with some related results. Let K , a subset of Euclidean space, be the union of a finite number of disjoint, compact, convex sets. Then there exists an integer

$N = N(K)$ with the following property: For any family $\{K_\alpha\}$, where each K_α is the transform of K by a non-singular affine transformation T_α (depending on α), if any N of the sets K_α have a non-empty intersection, then the intersection of all the sets K_α is not empty. Examples show that none of the underlined conditions may be dropped. (Contractor's abstract)

738

Institute for Advanced Study, Princeton, N. J.

ON A PROBLEM OF L. FEJES-TÓTH, by B. Grünbaum. Sept. 1959, 3p. (AFOSR-TN-59-981) (AF 49(638)253) AD 228282; PB 144471 Unclassified

Also published in Amer. Math. Monthly, v. 67: 882-884, Nov. 1960.

In Euclidean 3-space, a point is "hidden" by a set of spheres (which do not contain the point) if any ray issuing from the point intersects at least 1 of the spheres. Fejes-Tóth established that 6 congruent, non-intersecting spheres may hide a point. A proof is given that 5 congruent non-intersecting spheres may not hide a point. (Contractor's abstract)

739

Institute for Advanced Study, Princeton, N. J.

COMMON TRANSVERSALS FOR FAMILIES OF SETS, by B. Grünbaum. Oct. 1959, 12p. incl. refs. (AFOSR-TN-59-1036) (AF 49(638)253) AD 228281; PB 145069 Unclassified

Also published in Jour. London Math. Soc., v. 35: 408-416, Oct. 1960.

Let a family K of compact, convex sets be given. Conditions on K are investigated for which the existence of a straight line intersecting all the members of K results from the assumption that for every k -membered sub-family of K , where k is a suitable fixed integer, there exists a straight line intersecting all the members of the subfamily. (Contractor's abstract)

740

Institute for Advanced Study, Princeton, N. J.

DIFFERENCE METHODS FOR PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS, by M. Lees. Sept. 1959, 27p. incl. refs. (AFOSR-TN-59-1039) (AF 49(638)253) AD 229968; PB 145304 Unclassified

A general method is introduced and applied for determining the stability and convergence of difference schemes for parabolic equations with non-constant

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coefficients. The method is applied to an important subclass of the 2 and 3 level difference schemes currently in use for approximating solutions of parabolic equations. Applications to non-linear equations are also considered. (Contractor's abstract)

741

Institute for Advanced Study, Princeton, N. J.

INTEGRATION OF THE GOURSAT PROBLEM BY DIFFERENCE METHODS, by M. Lees. Oct. 1959, 18p. (AFOSR-TN-59-1109) (AF 49(638)253) AD 229917; PB 145318 Unclassified

Finite difference methods are used to solve the Goursat problem for linear and quasi-linear hyperbolic equations in characteristic form. In addition to existence and uniqueness theorems, several approximation theorems are derived. The results are based on an integral inequality for the solutions of the Goursat problem which is similar to the well-known energy inequality for hyperbolic equations. (Contractor's abstract)

742

Institute for Advanced Study, Princeton, N. J.

UNIQUE CONTINUATION FOR PARABOLIC DIFFERENTIAL EQUATIONS AND INEQUALITIES, by M. Lees and M. H. Protter. Oct. 1959, 21p. (AFOSR-TN-59-1110) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)253 and National Science Foundation) AD 229957; PB 145317 Unclassified

Also published in Duke Math. Jour., v. 28: 369-382, Sept. 1961.

Unique continuation theorems are proved for parabolic equations and inequalities. These continuation theorems have the following form: if a solution of a parabolic equation (or inequality) exists in a region and vanishes in a subregion, then it vanishes in the original region. As a consequence of 1 of the continuation theorems, the uniqueness of the 1st mixed, initial-boundary value problem for negative time is proved. (Contractor's abstract)

743

Institute for Advanced Study, Princeton, N. J.

ON POLYHEDRA IN E^3 HAVING ALL FACES CONGRUENT, by B. Grünbaum. Oct. 1959 [5]p. (AFOSR-TN-59-1129) (AF 49(638)253) AD 229958; PB 145487 Unclassified

Also published in Bull. Research Council Israel, v. 8F: 215-218, Apr. 1960.

The following problem was recently proposed by H. Steinhaus: Do there exist polyhedra which have (1) n congruent faces where n is odd? (2) n congruent faces where $n > 30$ but there are no triangular faces? In this report the answer to the 2nd question is shown to be positive, the answer to the 1st question is shown to be negative, and the following theorem is proved: If all faces of a complex polyhedra in Euclidean 3-space are congruent, then the polyhedron has an even number of faces.

744

Institute for Advanced Study, Princeton, N. J.

ON SOME PROPERTIES OF CONVEX SETS, by B. Grünbaum. Nov. 1959, 4p. (AFOSR-TN-59-1157) (AF 49(638)253) AD 229959; PB 145490 Unclassified

Also published in Colloq. Math. (Poland), v. 8: 39-42, 1961.

A conjecture of H. Steinhaus on the diameters of plane sections of convex bodies in E^3 is disproved, and a positive result of a related nature is established. The conjecture reads: Prove that through each point inside a closed convex surface there is passing such a plane that this point lies on 1 of the longest chords of the curve of intersection.

Institute for the Study of Rate Processes, Salt Lake City, Utah
see Utah U. Inst. for the Study of Rate Processes, Salt Lake City.

Institute of Air Flight Structures, New York
see Columbia U. Inst. of Air Flight Structures, N. Y.

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[Instituto de Investigacion de Ciencias Biologicas, Montevideo (Uruguay).]

BEHAVIOURAL AND EEG EFFECTS OF TONES "REINFORCED" BY CESSATION OF PAINFUL STIMULI, by J. P. Segundo, C. Galeano and others. [1959] [27]p. incl. illus. diagrs. (AFOSR-TN-59-1144) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)585 and Rockefeller Foundation)

Unclassified

Also published in Proc. Symposium on Brain Mechanisms and Learning, Paris (France) [1960] Oxford, Blackwell Scientific Publications, 1961, p. 285-291. (AFOSR-1191)

Experiments were performed on cats with chronically implanted electrodes in which application and subtraction of prolonged subcutaneous stimuli (SS) induced

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variable but characteristic electrographic (in somatic sensory cortex) and behavioral patterns. During training stage I, a tone (T) was presented repeatedly until rendered inoperant (habituation). During stage II, SS was consistently interrupted 2-5 seconds after T initiation. A learning process was established by this 're-inforcement' of indifferent T with interruption of pain and cats eventually came to react to T in a consistent fashion. Behavioral responses to T initiation (during SS) resembled those to SS subtraction (without previous T) and consisted in head, eye and/or limb movements, frequently carrying from a 'tense' to a 'relaxed, natural' position. Electrographically (and even under Flaxedil) T masked potentials evoked by SS on contralateral sensory cortex; amplitude and duration of individual waves were reduced markedly (initial spike was resistant). T effects were compared electrographically as to quality, intensity and distribution with results induced by application of other agents known to reduce cortical evoked potentials (e.g., SS voltage reduction; EEG 'activating' influence as brain stem stimulation or presentation of novel, intense or conditioned sounds). T effects exhibited specificity: non-reinforced tones of different frequency become ineffectual; T influence could be restricted to the somatic sensory areas. T application was followed by EEG 'activation', generalized or localized (to sensory cortices and to nucleus medialis dorsalis of thalamus); delayed and transitory reinforcement of slow rhythms also occurred. Experiments indicated that changes (behavioral, EEG) induced by painful stimuli are subject to variations 'spontaneous' and provoked; they indicated, moreover, that learned issues established through adequate training are significant. (Contractor's abstract)

746

Instituto de [Investigación de] Ciencias Biológicas,
Montevideo (Uruguay).

SOMATIC FUNCTIONS OF THE NERVOUS SYSTEM,
by J. P. Segundo and C. Galeano. [1959] [40]p. incl.
refs. (AFOSR-TN-59-1145) (Sponsored jointly by Air
Force Office of Scientific Research under AF 49(636)-
565 and Rockefeller Foundation) AD 244780
Unclassified

Also published in *Ann. Rev. Physiol.*, v. 22: 433-472,
1960.

Research upon certain problems, such as receptor activation, motoneurons, sensory controls, spinal mechanisms, sleep and wakefulness, and central brain-stem, issuing from important aggregations of experimental data, posed in a coherent fashion, and set within the scope of present day techniques, has continued to yield its usual significant contribution. But outside of these fields, novel facts or shrewd comments indicated other lines of investigation, notably the exploration of dendrites, initial, and terminal axons, the study of interactions between adjacent receptors or neurons, mathematical analysis of unitary discharge patterns, and the

utilization of refined techniques on free unanesthetized animals. Along these routes lie promising and perhaps eventually rewarding fields of endeavor. (Contractor's abstract)

747

Instituto de Química Física, Madrid (Spain).

KINETICS OF THE SULPHURATION OF METALLIC
SURFACES, by J. Llopis, J. M. Gamboa, and L.
Arizmendi. Annual rept. no. 2, May 1959, 43p. incl.
illus. diagrs. tables, refs. (AFOSR-TN-59-597) (AF 61-
(514)1329) AD 217160; PB 143661 Unclassified

The kinetics of the surface reaction of copper with solutions of diphenylthiourea in xylene has been followed by the radiochemical method. The kinetic law of the film growth is linear with time, and the energy of activation is $\Delta H^* = 14.2$ kcal/mol. In the reaction of diethyl trisulfide solutions with copper, the growth kinetic law is linear with time, and the activation energy is $\Delta H^* = 17.5$ kcal/mol. The films of sulfide formed are at 1st coherent and show interference colors; however, black circular stains soon appear and the corrosion rate increases appreciably with time. The influence of free sulfur in mixed xylene solutions has been studied, and these experiments show that the rate of formation of the film increases with S concentration. (Contractor's abstract)

748

Instituto de Química Física, Madrid (Spain).

KINETICS AND MECHANISM OF THE DEHYDRO-
GENATION OF ISO-PROPYL ALCOHOL ON Cr_2O_3 , by
J. F. García de la Banda and G. Kremenčić Orlandini.
Nov. 1956, 51p. incl. diagrs. tables, refs. (Technical
note no. 1) (AFOSR-TN-59-36) (AF 61(514)1330)
AD 209208; PB 136709 Unclassified

Also published in *Anal. Real Soc. Espan. Fís. Quím.*,
v. 55B: 465-476; 477-492, May 1959.

The kinetics of the reaction of dehydrogenation of isopropyl alcohol on Cr_2O_3 at 350, 360, 410, 440, 470, and 500°C was studied by means of a differential reactor. Isopropyl alcohol-acetone-hydrogen mixtures were studied with catalyst pellets, using a technique which allowed for the results to be reduced to those obtained with powder catalysts. The Arrhenius plot for all isopropyl alcohol-acetone mixtures gave 2 different straight lines, one defined by the points corresponding to the reaction rates measured at 350, 360, and 410°C, and the other by those corresponding to 440, 470, and 500°C. The reaction rate first decreased with increasing partial pressure of H, then increased, from a certain value of the pressure depending on the reaction mixture and the temperature, and finally went through a minimum and decreased again. Fourteen possible reaction mechanisms

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and their corresponding rate equations were considered in the analysis of the experimental results. The most probable mechanism is one with 2 equal active centers in which isopropyl alcohol, acetone, and hydrogen are all adsorbed, the rate-determining step being the surface reaction.

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Instituto Nacional de Técnica Aeronáutica Esteban Terradas, Madrid (Spain).

COMBUSTION OF SPRAYS IN AN OXIDIZING ATMOSPHERE, by G. Millán, S. Sanz, and I. Da Riva. [1959] [36]p. incl. diagrs. table, refs. (AFOSR-TN-59-818) (AF 61(514)734-C) AD 225647; PB 147142
Unclassified

Also published in Proc. Fifth Internat'l. Cong. of Combustion Engines; Diesel Engines and Gas Turbines up to 1500 HP, Wiesbaden (Germany) (June 13-19, 1959), [Paris, CIMAC] 1959, p. 273-293.

The mathematic representation of the statistical size distribution of droplets injected into the combustion chamber of diesel engine and a gas turbine, is discussed. After consideration is given to some of the distributions proposed by other Technical Sciences (Meteorology - Gravimetry, etc), the Mugele Evans distribution is selected as the most adequate for the problem. The combustion of a spray under ideal conditions is analyzed. It is assumed for it that each droplet burns in accordance with a theoretical law whose validity has been experimentally verified for a few simple cases-isolated droplets at rest or in motion, set of droplets in motion whose relative positions remain invariable, etc. The particular cases considered are the following: combustion at the beginning and end of the injection. Combustion at an instant sufficiently far in time from both the above cases. Combustion of a volume injected instantaneously as approximately occurs in a diesel engine and, finally, superposition of isolated successive injections. The scaling of atomizers and combustion chambers is analyzed. (Contractor's abstract)

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Instituto Nacional de Técnica Aeronáutica Esteban Terradas, Madrid (Spain).

COMBUSTION OF MONOPROPELLANT DROPLETS. THEORETICAL RESULTS, by C. S. Tarifa and P. Pérez del Notario. Dec. 15, 1958, 1v. incl. diagrs. tables. (AFOSR-TN-59-463) (AF 61(514)997) AD 215268; PB 140776
Unclassified

In the present work the following problems have been studied: (1) Extension of the integration method for overall reactions of n^{th} order and Lewis-Semenov numbers different from one. (2) Comparison of the

results for 2nd order chemical kinetics with those obtained by means of numerical integration of the equations. (3) Results of the investigation for 1st and 2nd order chemical kinetics. Study of the principal variables of the process: burning rates, evaporation constants, flame front radius, reaction zone thickness, maximum temperatures, etc., in functions of the principal parameters that influence the process, such as initial diameter of the droplet, activation energy, temperature at the infinite, pressure, etc. (4) Numerical application for the hydrazine, taking the decomposition reaction model proposed by Adams and Stock. (Contractor's abstract)

751

Instituto Nacional de Técnica Aeronáutica Esteban Terradas, Madrid (Spain).

DISTRIBUTION OF RADICALS IN LAMINAR FLAMES. I. CRITERIUM OF VALIDITY OF THE STEADY STATE ASSUMPTION, by G. Millán and I. Da Riva. Jan. 31, 1959 [33]p. incl. diagrs. refs. (AFOSR-TN-59-626) (AF 61(514)997) AD 217811; PB 143173
Unclassified

It is demonstrated that the applicability of the steady state assumption depends on the value of a certain dimensionless parameter, in which the effects of reaction and diffusion of the radicals are combined. Besides, a method of recurrence is developed which enables successive approximations for the distribution of the radicals to be obtained from that corresponding to the steady state. Finally a study is made of a mathematical model which, preserving all the properties of the flame, enables an easy comparison of the exact solution with the approximate ones obtained by means of the proposed methods. (Contractor's abstract)

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Instituto Nacional de Técnica Aeronáutica Esteban Terradas, Madrid (Spain).

DISTRIBUTION OF RADICALS IN LAMINAR FLAMES. II. APPLICATION OF THE CRITERIUM OF VALIDITY OF THE STEADY STATE ASSUMPTION TO SEVERAL FLAMES, by I. Da Riva and G. Millán. Jan. 31, 1959 [52]p. incl. diagrs. tables, refs. (AFOSR-TN-59-627) (AF 61(514)997) AD 217812; PB 143172
Unclassified

An application of the criterium on the validity of the steady state assumption (item no. 751, Vol. III) to various cases corresponding to flames studied by different authors. For it, the differential equation deduced for the concentration of the radical is integrated by means of the perturbation method set out in the above mentioned reference. With a view to simplifying the numerical calculation, the concentration of the principal species and of the radicals distinct from that under consideration, if existent, have been approximated by means of appropriate functions. The two first perturbations were

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normally sufficient to evaluate the accuracy with which the steady state assumption enables the concentration of the radicals to be calculated. The criterium set out makes it possible to prove that the steady state assumption is sufficiently approximate to calculate the concentration of the radicals in the following cases: ozone flame, hydrogen radical in the hydrogen-bromine flame and, hydrogen flame. On the contrary, in the case of the bromine radical in the hydrogen-bromine flame and particularly in the hydrazine flame, the parameter for the validity of the assumption is very small and consequently the method of perturbations does not converge and the steady state assumption for the concentration of the radicals gives large deviations with respect to their actual distributions. (Contractor's abstract)

753

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

AN EXPERIMENTAL INVESTIGATION ON THE COMBUSTION OF MONOPROPELLANT DROPLETS, by P. Pérez del Notario and C. S. Tarifa. Jan. 20, 1959 [24]p. incl. illus. diagrs. tables. (AFOSR-TN-59-628) (AF 61(514)997) AD 217813; PB 143171 Unclassified

An investigation was made to obtain the velocities of combustion of monopropellant droplets within an inert atmosphere. Combustion of droplets of N_2H_4 , ethyl nitrate, and of a mixture of HNO_3 and amyl acetate could not be obtained in an N atmosphere by operating at ambient pressure at furnace temperatures of about $1000^\circ C$. The evaporation constants obtained in N coincided approximately with the theoretical results for evaporation of droplets in the absence of combustion. Combustion was achieved by introducing a mixture of O and N into the furnace; the ignition temperature diminished appreciably upon increasing the proportion of O. Upon ignition the values of the evaporation constants increased abruptly above those obtained in an N atmosphere; the values thereafter increased in a continuous manner as the temperature of the atmosphere of the furnace rose. The form of the functions $k = f(T)$, when k is the evaporation constant and T is the furnace temperature, in the combustion processes could not be determined exactly because of the dispersion of the results. The results which were qualitatively similar were obtained for N_2H_4 and ethyl nitrate. (Contractor's abstract)

754

Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

COMBUSTION OF FUEL SPRAYS, by G. Millán, I. Da Riva, and S. Sanz. Jan. 31, 1959 [27]p. incl. diagrs. table. (AFOSR-TN-59-629) (AF 61(514)997) AD 217814 Unclassified

The method proposed by Probert (Philos. Mag., v. 37: 94-105, Feb. 1946) for the study of the evaporation of sprays is applied to the analysis of the combustion of a fuel spray burning in an oxidizing atmosphere. The study is applied to various typical cases, corresponding to the starting and the stopping of the injection, as well as to the continuous functioning, and to the case of periodical injections of short duration. The Rosin-Rammler function of size distribution, used by Probert, is substituted here by that of Mugele-Evans, which by limiting the maximum size of the droplets, enables a better approximation to the real distributions. Some general conclusions of a qualitative nature are obtained regarding the most suitable characteristics of a spray. The great influence that the distribution function and the medium size of the droplets have on the processes under consideration, is also shown. The lack of experimental data constitutes an important difficulty in judging the validity of the model considered. (Contractor's abstract)

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Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

[COMBUSTION OF SPRAYS, DROPLETS AND FLAMES], by G. Millán. Final rept. Aug. 1, 1956-Jan. 31, 1959. Feb. 25, 1959, 9p. incl. refs. (AFOSR-TR-59-68) (AF 61(514)997) AD 217815; PB 143152

Unclassified

Studies of homogeneous combustion were made to contribute to the theoretical study of the characteristics of the laminar flames, by taking the existing semi-analytical methods as the starting point and including some nonsteady cases, such as ignition of a combustible and homogeneous gaseous mixture, as well as others of flame with heat losses. An investigation was also made of the combustion of monopropellant droplets and of fuel sprays. A semianalytical method was developed for evaluating flames of 1st and 2nd order reactions. The basis of the method consists of approximating, by means of an exponential function, the fractional flux of the reactants. The applicability of the steady state assumption for the computation of the distribution of radicals in the study of flames with chain reactions was investigated. Attempts were made to analyze the flammability of a determined homogeneous combustible mixture at rest when a nucleus of the same was heated instantly up to a high temperature. A theoretical study was performed on a fuel spray in an oxidizing atmosphere by applying the Probert method, but using the Mugele-Evans statistical distribution function of the size of the droplets. The combustion of monopropellant drops was studied by considering diffusion and approximating the chemical kinetic process by means of over-all reactions. The principle parameter controlling the combustion was the dimensionless relation of the activation energy to the reaction heat.

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Instituto Nacional de Tecnica Aeronautica Esteban Terradas, Madrid (Spain).

A THEORETICAL INVESTIGATION OF THE COMBUSTION OF LIQUID BIROPELLANT DROPLETS, by C. S. Tarifa and P. Pérez del Notario. Apr. 11, 1960 [73]p. incl. diagrs. tables, refs. (Technical note no. 1) (AFOSR-TN-59-975) (AF 61(052)221) AD 244459
Unclassified

Combustion of droplets of bipropellant systems consisting of a fuel (oxidizer) droplet within the vapors of an oxidizer (fuel) is studied considering chemical kinetics and equal or different molecular weights of the chemical species. The problem is solved by integrating the differential equations of the process by means of an approximated analytical method, and the approximation furnished by such method is verified by integrating numerically the equations of the process for several representative cases. The principal variables of the process, e.g. burning rates, flame/droplet radius ratio, and maximum temperature, are expressed as functions of the dimensionless product of the pressure multiplied by the droplet radius, for several values of the main parameters of the process, i.e. activation energy, temperature of the surrounding atmosphere, etc. Several important conclusions are obtained, e.g. that when either the pressure or the droplet radius tend towards infinity, results coincide with those obtained by assuming that the reaction rate is infinitely fast, and that there exist minimum values of either the pressure or the droplet radius under which combustion is not possible. These theoretical conclusions have been experimentally verified. (Contractor's abstract)

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Iowa State [U. of Science and Tech.] Ames.

THE ASYMPTOTIC BEHAVIOR OF SOLUTIONS OF PENDULUM-TYPE SOLUTIONS, by G. Seifert. [1959] [12]p. incl. diagrs. refs. (AF 18(603)51)
Unclassified

Published in Ann. Math., v. 69: 75-87, Jan. 1959.

This report is concerned with the asymptotic behavior of solutions $(\theta(t), z(t))$ of a system of differential equations of the form $\dot{\theta} = z$, $\dot{z} = g(\theta) - \alpha f(\theta)z + p(t)$. Here α is a positive constant, and the functions f , g , and p satisfy the following conditions: (1) $f(\theta) > 0$, $f(\theta + 2\pi) = f(\theta)$, $g(\theta + 2\pi) = g(\theta)$ for all θ ; (2) $p(t)$ and the derivatives $g'(\theta)$ and $f'(\theta)$ are continuous everywhere; (3) there exists a constant k such that $|p(t)| < k$ for all t , and that each of the equations $g(\theta) \pm k_1 = 0$, $0 < k_1 < k$, has simple roots. The autonomous system is studied; i.e., system with $p(t) = 0$ identically. The case where $p(t)$ is non-constant and in particular of period τ is also treated.

758

Iowa State [U. of Science and Tech.] Ames.

TEMPERATURE DEPENDENCE OF SOUND DISPERSION IN HALO-METHANE GASES, by R. Amme and S. Legvold. [1959] [5]p. incl. diagrs. tables, refs. (AF 18-(600)1496)
Unclassified

Published in Jour. Chem. Phys., v. 30: 163-167, Jan. 1959.

Sound dispersion has been examined in eight halo-methane gases near 100°C and 200°C, and four near 300°C. The observed relaxation times have been used along with data obtained previously at room temperature to calculate the vibrational collision lifetimes over this temperature range. The results have been compared with theoretical predictions of Schwartz and Herzfeld which used an attractive term in the potential to help account for the effect of long-range forces. Agreement is good, although several lifetimes at room temperature appear somewhat small. (Contractor's abstract)

759

Iowa State [U. of Science and Tech. Statistical Lab.] Ames.

SOME FAMILIES OF CONTAGIOUS DISTRIBUTIONS, by S. K. Katti and J. Gurland. [1959] 46p. incl. tables, refs. (AFOSR-TN-59-4) (AF 49(638)43) AD 238184; PB 143362
Unclassified

An attempt is made to find forms of theoretical distributions based on realistic biological models, which provide a good fit for the type of data that are collected, and which prove feasible for developing suitable techniques for the analysis of data. The work includes: (1) a study of some families of contagious distributions from the point of view of their derivation; (2) comparison of these distributions using characteristics such as skewness, kurtosis, and the ratio of frequencies; (3) the estimating of parameters by various methods in order to gain some empirical evidence about their relative merits; and (4) comparison of fits using chi-square to see if any general conclusions can be suggested on an empirical basis regarding the best fit.

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Iowa State [U. of Science and Tech. Statistical Lab.] Ames.

SIZE AND POWER OF TESTS USING SOME OPTICAL WELCH-TYPE STATISTICS, by R. S. McCullough and J. Gurland. [1959] 26p. incl. diagrs. tables, refs. (AFOSR-TN-59-177) (AF 49(638)43) AD 211317; PB 142235
Unclassified

By using a finite series representation of the distribution of a certain class of statistics, and by utilizing other techniques, 2 types of statistics are developed for testing the hypothesis of the equality of the means

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of 2 normal populations, using small sample sizes. One type of statistic, called unilateral, effectively controls the size of the test under variance heterogeneity, if it is known a priori that the variance of one specified population is greater than that of the other. The 2nd type of statistic, called bilateral, controls the size when there is no a priori knowledge of the population variances. Tables are included specifying both types of statistics, and giving size and power. (Contractor's abstract)

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Iowa State U. of Science and Tech. [Statistical Lab.] Ames.

ON THE ABSOLUTE DIFFERENCE AND ABSOLUTE DEVIATION OF DISCRETE DISTRIBUTIONS, by S. K. Katti. [1959] 28p. (AFOSR-TN-59-178) (AF 49(638)-43) AD 211318; PB 142236 Unclassified

Let X_1 and X_2 be two independent random variables with probability generating functions (p.g.f.), $g_1(z)$ and $g_2(z)$, respectively. Let the probability of obtaining $X_1 = i$ and $X_2 = j$ be denoted by P_i and Q_j . The definition of the mean difference and the mean deviation may be regarded as particular cases of the more generalized ones, defined as: (1) $\Delta_r = \sum_{i,j} |i-j| r P_i Q_j$ and (2) $\delta_r = \sum_i |i-m| r P_i$ where m is any arbitrary

number and the summations are with respect to all the admissible values of the random variables X_1 and X_2 .

Methods are presented for obtaining general expressions for Δ_r and δ_r through the use of moment generating functions. Some illustrations are given to indicate the feasibility of these methods in determining the values of Δ_r and δ_r . (Contractor's abstract)

Israel Inst. of Tech., Haifa.

see Technion-Israel Inst. of Tech., Haifa.

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Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

MAGNETIC VISCOSITY DUE TO INTERSTITIAL ATOMS ANCHORED IN DISLOCATIONS. MAGNETIC VISCOSITY DUE TO MOTION OF DISLOCATIONS, by G. Biorci, A. Ferro, and G. Montalenti. Oct. 1958 [62p. incl. illus. diagrs. tables, refs. (Technical note no. 2a) (AFOSR-TN-59-85) (AF 61(514)1331) AD 210145; PB 150695 Unclassified

The correspondence between mechanical and magnetic relaxation was shown to be valid when interstitial atoms of carbon in iron diffuse in highly distorted regions close to dislocations. The values of the diffusion constants obtained from magnetic measurements are in

agreement with those obtained from internal friction:

$Q = 32,000 \text{ cal/gr at.}, \tau_0 = 10^{-13} \text{ sec.}$ The specimens

were iron sheets loaded with carbon, cold rolled at 7% and aged at room temperature. The magnetic viscosity due to dislocations and its correspondence with mechanical relaxation were examined. The specimens were of pure iron of different origin. Each specimen was composed of very few crystals, so that each could be considered as a single crystal. Above 320°C the well annealed Armco specimens show a viscosity field of about 0.5 A/m. The correspondence with mechanical relaxation and the shape of the curve of the magnetic relaxation vs field strength seem to prove that the observed magnetic viscosity is due to motion of dislocations. The single crystals cold rolled at 2% have a viscosity field appearing at lower temperatures and remarkably larger than in the annealed specimens.

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Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

MAGNETIC VISCOSITY IN IRON DUE TO CARBON ATOMS ANCHORED IN DISLOCATIONS, by G. Biorci, A. Ferro, and G. Montalenti. [1959] [4]p. incl. diagrs. refs. [AF 61(514)1331] Unclassified

Published in Jour. Appl. Phys., v. 30: 1732-1735, Nov. 1959.

A specimen of iron containing 0.01% of C in solid solution was cold worked by 7% and aged at room temperature. After this treatment it shows a new peak of magnetic viscosity at 180°C. The diffusion process giving rise to the peak is controlled by an activation energy of about 32,000 cal/g atom and a time constant at infinite temperature of about 10^{-14} sec. These figures agree with those of a peak of internal friction observed in similar specimens by Kê and by Köster, and interpreted as due to diffusion of C atoms in the surroundings of the dislocations. Hence the peak magnetic viscosity can be related to the same mechanism. (Contractor's abstract)

764

Istituto Elettrotecnico Nazionale "Galileo Ferraris", Turin (Italy).

EXPERIMENTS ON THE SURFACE ELECTRICAL CONDUCTION IN METALS (FINAL PART), by G. Bonfiglioli and R. Malvano. [1959] [26]p. incl. diagrs. (Technical note no. 2a) (AFOSR-TN-59-86) (AF 61-514)1333) AD 210146 Unclassified

Experimental results are given, concerning surface conductivity measurements made on Au, Sb, Bi, and Cu films, the measurements having been carried on at different temperatures between about -20 and +80 °C.

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The existence of localized surface states at the interface metal/dielectric appears confirmed, and tentative values of the trap depths concerned with them are given. A formalism is developed which furnishes a 1st approach to a phenomenological interpretation of the so-called surface mobility. (Contractor's abstract)

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Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

OPTICAL MICROSCOPY EXAMINATION OF THE SURFACE OF GERMANIUM SINGLE CRYSTALS, by G. Bonfiglioli, A. Ferro, and A. Mojoni. [1959] [11]p. incl. illus. tables. (Technical note no. 1d) (AFOSR-TN-59-958) (AF 61(514)1333) AD 226423; PB 143962
Unclassified

Results are presented of (optical) microscopy observations of etching patterns on Ge single crystals. Several specimens of different origin and characteristics were examined, and the micrographs obtained are given a brief comment. Some consideration is given to the values obtained for the etch pits density/unit area, and for 2 specimens, such a parameter is correlated with the excess carrier's lifetime with reasonable results. An interpretation is offered, on the grounds of very evident photographic proofs, of the so-called primary structure in CP4 - etched Ge. It is shown that such a structure is due to the progressive rounding off of the etch pits which belonged to dislocations ending on lattice planes already taken away by the etchant. (Contractor's abstract)

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Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

SENSITIVE CIRCUIT FOR THE DETECTION OF SMALL EFFECTS OF RESISTANCE MODULATION, by G. Bonfiglioli and R. Malvano. [1958] [2]p. incl. diagr. (AFOSR-TN-59-1074) (AF 61(514)1333) AD 230375
Unclassified

Also published in Rev. Scient. Instr., v. 29: 788-789, Sept. 1958.

A synchronous demodulation circuit is described in which a zero beat frequency is obtained and detected by a dc instrument whenever the resistance element to be examined is supplied with ac and subjected at the same time to a modulating agent of the same frequency. It is pointed out that for a symmetrical choice of the reactances, the value of the dc potential drop at the terminals of the modulated resistance R is given by $V = \langle R \cdot I_x \rangle A_v = (I_0 R_0 k \cos \alpha) / 4$ where I_0 means amplitude of the supply current, $R(t) = R_0 (1 + k \cos \omega t)$ represents the undulated resistance examined, and α is the phase difference between $R(t)$ and the bridge current.

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Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

FURTHER INVESTIGATIONS ON THERMOLUMINESCENCE AND F CENTERS, by G. Bonfiglioli, P. Brovotto, and C. Cortese. [1959] [14]p. incl. diagr. tables. (Technical note no. 2d) (AF 61(514)1333) AD 232065; PB 145674
Unclassified

This note is concerned with investigations both experimental and theoretical which consisted of the recording and analyzing of glow curves and separate peaks of light. Several salts were investigated: alkali halides (NaF, NaI, NaBr, KI, KCl, KBr) and CaCO_3 (calcite form) and K_2SO_4 , of which activation energy curves were made on NaF, NaBr, KCl, and KBr. One result of the work consists of the extension of the results already established for NaCl to the case of KCl. This is the identification of luminophor centers as V_2 and V_3 centers. Some preliminary remarks are also presented about the meaning of thermal dissociation energy for F centers. It is shown that, to measure this quantity, the methods followed thus far are unsuitable, because the correct kinetics of the process is not taken into account. The 2nd order kinetics, through F and V centers recombination must lead to different interpretations and appears first to be able to give a basis for accounting for the results of thermal bleaching experiments.

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Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

AN EXPERIMENT ON THE POSSIBLE DEPENDENCE OF SUPERCONDUCTIVE TRANSITION TEMPERATURE ON THE SURFACE CHARGE DENSITY, by G. Bonfiglioli and R. Malvano. [1959] [9]p. incl. diagr. (Technical note no. 3a, suppl.) (AFOSR-TN-59-1234) (AF 61(514)1333) AD 232074; PB 145673
Unclassified

The present note discusses gathering electric charges on the surface of a superconductor by means of a transverse electrostatic field leading to a change in the transition temperature. A short description of the experiment performed is given, which actually turned out to be negative, or, at least, inconclusive. (Contractor's abstract)

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Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

THEORY OF THE ISOTHERMAL BLEACHING OF F CENTERS PRODUCED BY IRRADIATION IN ALKALI HALIDES, by G. Bonfiglioli, P. Brovotto, and C.

AIR FORCE SCIENTIFIC RESEARCH

Cortese. [1959] [14]p. incl. diagrs. table. (Technical note no. 3d) (AFOSR-TN-59-1315) (AF 61(514)1333) AD 232060; PB 145681
Unclassified

A quantitative interpretation of the thermoluminescence of irradiated alkali halides is applied to account for the experimental results on thermal bleaching of the optical density in the materials. The calculations fit well with experiment and indicate that the presence of several species of V-centers is responsible for the interpretation difficulties.

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Istituto Elettrotecnico Nazionale "Galileo Ferraris",
Turin (Italy).

SURFACE STATES IN METALS, by G. Bonfiglioli and R. Malvano. [1959] [6]p. incl. diagrs. (AFOSR-J33) [AF 61(514)1333] AD 297150
Unclassified

Published in Phys. Rev., v. 115: 330-335, July 15, 1959.

This paper deals with measurements of conductivity modulation in metals by an electric field. The measurements have been performed using a new technique, which permits reaching an accuracy sensibly higher than that obtained in experiments already published. Measurements on Au, Sb, and Bi films have been carried out at different temperatures between about -20° C and + 80° C. The existence of localized and conducting "surface states" at the metal/dielectric interface seems to be experimentally confirmed. (Contractor's abstract)

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Istituto Nazionale di Ottica, Florence (Italy).

ON THE ELECTRICAL RESPONSE OF THE HUMAN EYE TO RED STIMULI OF DIFFERENT TIME DISTRIBUTION OF LUMINANCE, by L. Ronchi. [1958] [2]p. incl. diagr. table, refs. (AF 61(052)17)
Unclassified

Published in Jour. Opt. Soc. Amer., v. 48: 437-438, July 1958.

The responses to red stimuli presenting different distributions of time luminance are compared. The height of the x-wave seems to be independent of time distribution of the light stimulus while the height of the b-wave is greater, the greater the time of variation of the luminance. The latencies to peak of both waves are greater with a slowly rising stimulus than with a steep stimulus.

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Istituto Nazionale di Ottica, Florence (Italy).

ON THE BEHAVIOR OF THE HUMAN ERG OVER A

WIDE RANGE OF LUMINANCES, by L. Ronchi. [1959] [13]p. incl. diagrs. tables, refs. (AFOSR-TN-59-119) (AF 61(052)17) AD 210424; PB 139642
Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 449-461, Sept.-Oct. 1958.

The behavior of the human ERG (electroretinogram) obtained by stimulating the dark-adapted human retina with stimuli (blue, green, or white) lasting 25 msec (or more) is studied over a wide range of luminances. Peculiar effects are noticed at high levels, beyond the saturation level of the scotopic b-wave. The inhibition of rods over cones seems to be loosened, and the response shows a mixed photopic scotopic activity; further, an unexpected enhancement of the b-wave is found before the start of the inhibition of the cones over the rods. At middle levels (that is for heights ranging between 100 and 500 μ v), three types of b-waves may appear, in response to a given stimulus: slow, steep short latency, and steep long latency. The last type is more frequent for blue than for green, and it seems to inhibit the x-wave in a lesser degree than the other types of responses. (Contractor's abstract)

773

Istituto Nazionale di Ottica, Florence (Italy).

MAY PSYCHOLOGICAL FACTORS INFLUENCE THE ELECTRORETINOGRAPHIC RESPONSE?, by M. Bittini and L. Ronchi. [1959] [2]p. (AFOSR-TN-59-120) (AF 61(052)17) AD 210425
Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 417-418, Sept.-Oct. 1958.

Some facts concerned in the course of electroretinographic recordings carried out on 2 subjects suggest that the electroretinographic response may be influenced by psychological factors. This hypothesis, which has as its theoretical basis centrifugal control, may explain the differences concerning the presence of a consensual response in the unstimulated eye.

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Istituto Nazionale di Ottica, Florence (Italy).

ON THE FUSION CONDITIONS OF A COLORED FLICKERING FIELD, by M. Bittini. [1959] [7]p. incl. diagrs. refs. (AFOSR-TN-59-121) (AF 61(052)17) AD 210426
Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 442-448, Sept.-Oct. 1958.

The behavior of the critical luminance (L_c) for a frequency varying between about 6 and 60 pulses/sec, for 1° colored test field located either at the fovea or at

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10° in the periphery was investigated. Both a sequence of saw-tooth stimuli and a sequence of rectangular stimuli were used. In extrafoveal vision the pulse shape is found to affect the L_c of a green flickering test field, while with blue and red light the effect disappears. The contribution of rods to the so-called cone branch of the curve, obtained by plotting critical flicker frequency against luminance, is discussed. (Contractor's abstract)

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Istituto Nazionale di Ottica, Florence (Italy).

ON THE QUESTION OF THE EXISTENCE OF ROD-LIKE-CONES IN THE HUMAN RETINA, by L. Ronchi and M. Bittini. [1959] [8]p. incl. refs. (AFOSR-TN-59-333) (AF 61(052)17) AD 213654 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 538-545, Nov.-Dec. 1958.

The possibility is discussed that the so-called rod-like-cones represent, at least for the human retina, the result of an interaction between the classical rods and the extra-foveal cones, peculiarly sensitive to blue. (Contractor's abstract)

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Istituto Nazionale di Ottica, Florence (Italy).

ON THE FACTORS WHICH INFLUENCE THE HUMAN SCOTOPIC ELECTRORETINOGRAM AT DIFFERENT LUMINANCE LEVELS, by M. Bittini and L. Ronchi. [1959] [6]p. incl. diagrs. tables. (AFOSR-TN-59-334) (AF 61(052)17) AD 213655 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 318-323, July-Aug. 1958.

An investigation is made on how factors such as the total time of variation of the luminance and the behavior of the time derivative of luminance influence the human scotopic electroretinogram. The first factor is found to influence the response to green (but not to blue) stimuli; the amount of the effect is noticeable at low levels and decreases when luminance is increased. The latter factor seems to be unimportant at any level for both colors. The results are discussed in terms of the cues for brightness discrimination furnished by the electroretinographic response.

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Istituto Nazionale di Ottica, Florence (Italy).

THE TOTAL TIME OF VARIATION OF THE LUMINANCE AS FACTOR AFFECTING THE HUMAN

SCOTOPIC ELECTRORETINOGRAM, by L. Ronchi. [1959] [2]p. incl. diagr. (AFOSR-TN-59-335) (AF 61(052)17) AD 213656 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 517-518, Nov.-Dec. 1958.

It is thought that the time of variation of the luminance should be considered as a factor influencing the green scotopic b-wave at submaximal levels. By taking into account the fact that the same does not happen with blue light, it is emphasized that the system responsible for the scotopic b-wave shows 2 main groups with different time constant values.

778

Istituto Nazionale di Ottica, Florence (Italy).

ON THE CORRECTION OF THE DISTORTED ELECTRORETINOGRAPHIC RECORDS, by M. Bittini. [1959] [5]p. incl. diagrs. table. (AFOSR-TN-59-336) (AF 61(052)17) AD 213657 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 13: 533-537, Nov.-Dec. 1958.

A description is given of a method to be followed for correcting the distorted electroretinograms recorded by the aid of a capacitance coupled amplifier. The correction is then applied to the results of some recent researches. (Contractor's abstract)

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Istituto Nazionale di Ottica, Florence (Italy).

BASIC RESEARCH IN THE FIELD OF VISION. PART 1. VISION WITH STABILIZED RETINAL IMAGES, by A. Fiorentini and A. M. Ercoles. PART 2. EFFECT OF THE ILLUMINATION OF ONE EYE ON THE APPARENT BRIGHTNESS OF A FIELD SEEN BY THE OTHER EYE, by A. Fiorentini and T. Radici. PART 3. ON THE INFLUENCE OF THE TIME LUMINANCE DISTRIBUTION ON THE REACTION OF THE DARK-ADAPTED RETINA. PSYCHOPHYSICAL AND ELECTRORETINAL INVESTIGATION, by L. R. Rositani and M. Bittini. Final rept. Nov. 1958, 28p. incl. diagrs. table, refs. (AFOSR-TN-59-14) (AF 61(052)17) AD 210473; PB 139642 Unclassified

Some specific effects of contrast and of interaction which arise due to a variation of the light stimulus with time were investigated. From this general field 3 different topics were selected and the program was accordingly divided into 3 parts. The first research was undertaken to extend some previous investigations, on the role of eye movements in vision. Suppression of movement of retinal images was shown to have detrimental effects on border contrast. Part 2 concerned the mutual interaction of the 2 eyes. It was found that strong illumination of 1 eye depressed brightness sensation of the other eye

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when the latter was illuminated with lower intensity. This binocular inhibition seemed to be independent of the retinal location of the inhibiting stimulus, and to depend on the relative intensity of illumination at the 2 eyes. Part 3 was an investigation of the influence of the time variation of the luminance on fusion conditions and on electroretinal response. The results obtained suggest some practical applications. For increasing the visibility of a light signal it was necessary not only to use a flashing light, but to minimize the ratio of the blue components of the light source to the other components. The vision of images with diffused boundaries could be improved if their illumination pulsed near the fusion, and the pulse shape, the color of light, and the luminance level were suitably selected.

760

Istituto Nazionale di Ottica, Florence (Italy).

ON THE INFLUENCE OF THE INCOMPLETE ADAPTATION OF THE PERIPHERAL RETINA ON THE SPEED OF READING, by L. Ronchi and E. Ascarelli. [1959] [8]p. incl. diagrs. (AFOSR-TN-59-543) (AF 61-052)80 AD 210559 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14: 53-62, Jan.-Feb. 1959.

Changes in the speed of reading during the adaptation to light of the peripheral retina are investigated. The level of the peripheral field is mesopic, while that of the centrally viewed test-field is a moderate photopic level. A series of complex troubles are tested after the onset of the peripheral field, which are felt for several minutes, and consist of both facilitation and inhibition effects, lesser for a blue than for a green peripheral field. (Contractor's abstract)

781

Istituto Nazionale di Ottica, Florence (Italy).

IS IT POSSIBLE TO MEASURE THE CONTRAST ENHANCEMENT OF A FIGURE WITH "QUASI PERCEPTIVE CONTOURS"? by G. F. Mori. [1959] [3]p. incl. diagr. table. (AFOSR-TN-59-777) (AF 61-052)80 AD 220032 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14: 137-139, Mar.-Apr. 1959.

This preliminary report discusses the role played by a contour in determining the perception of a figure. The mechanisms responsible for perceiving the geometrical contour, even though portions of it are lacking, are analyzed. An attempt is made to measure the contour using different illumination strengths, and the conclusions of the tests are discussed.

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Istituto Nazionale di Ottica, Florence (Italy).

MAY OCULAR TREMOR EVOKE FLICKER SENSATION? by L. Ronchi. [1959] [2]p. (AFOSR-TN-59-778) (AF 61-052)80 AD 220033 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14: 140-141, Mar.-Apr. 1959.

The phenomenon observed when black and white parallel stripes are presented on a field is reported. The observation is called "apparent movement" or "contrast enhancement" by some researchers. The thin luminous stripes separated by large dark stripes on a field is the particular case studied in this report. It is stated that in this case the above effects disappear, and an evident flicker sensation is noticed. Values for the curve obtained by plotting the critical flicker frequency against luminance are stated. It is pointed out that ocular tremor, that is eye movement in relation to retinal action, and eye movements and visual perception, are the probable origin of the flicker sensation. The 2 conditions required to perceive the flicker are high contrast and light adaptation. The latter indicates that the cones play a role in the determination also.

783

Istituto Nazionale di Ottica, Florence (Italy).

ON THE INFLUENCE OF SYMPAMINE ON A PECULIAR RETINAL FUNCTION, by G. Salvi. [1959] [5]p. incl. diagrs. (AFOSR-TN-59-779) (AF 61-052)80 AD 225810 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14: 142-146, Mar.-Apr. 1959.

The effect of sympamine on the critical flicker fusion is investigated. A small retinal area (10° nasal) is stimulated by a sequence of pulses either rectangular or triangular. Before the absorption, fusion occurs at a critical luminance greater for the rectangular than for the triangular pulses. After the absorption (either systemic or local) such effect follows a complex behavior, and for the dosage considered in this research, about 30 min must elapse after absorption before attaining accurate visual responses (for peripheral vision at least). (Contractor's abstract)

784

Istituto Nazionale di Ottica, Florence (Italy).

VISIBILITY OF THE MACH BANDS AS A FUNCTION OF FIELD LUMINANCE, by A. M. Ercoles and A. Fiorentini. [1959] [6]p. incl. diagrs. (AFOSR-TN-59-781) (AF 61-052)80 AD 220031 Unclassified

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Also published in Atti Fondazione G. Ronchi, v. 14: 230-235, May-June 1959.

The visibility of a subjective contour (Mach band) was investigated as a function of luminance. It was found that the dark Mach band is visible at levels lower than the luminance threshold for the bright Mach band. At high levels, however, the luminance gradient required for the perception of the dark band is greater than the luminance gradient required for the bright band. (Contractor's abstract)

785

Istituto Nazionale di Ottica, Florence (Italy).

ON THE DISCREPANCY BETWEEN PSYCHOPHYSICAL AND ELECTRORETINOGRAPHIC SATURATION OF THE RETINAL MECHANISMS, by L. Ronchi and A. Tassinari. [1959] [5]p. incl. diagrs. refs. (AFOSR-TN-59-782) (AF 61(052)80) AD 220034 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14: 250-254, May-June 1959.

It is known that when the ERG is recorded by the micro-electrode technique, the size of the response decreases when the distance from the anterior surface of the retina is increased. This fact suggests that the retina behaves like an amplifier, with, say, 3 stages. The 3rd stage only is referred to a peculiar structure (the ganglion cell layer). The electroretinographic response (recorded by the aid of the corneal electrode technique) is compared to the output after the 1st 2 stages, the psychophysical response to the overall output. This model seems to account for the fact that the electroretinographic rod saturation occurs at luminances higher than

those determining the psychophysical rod saturation. (Contractor's abstract)

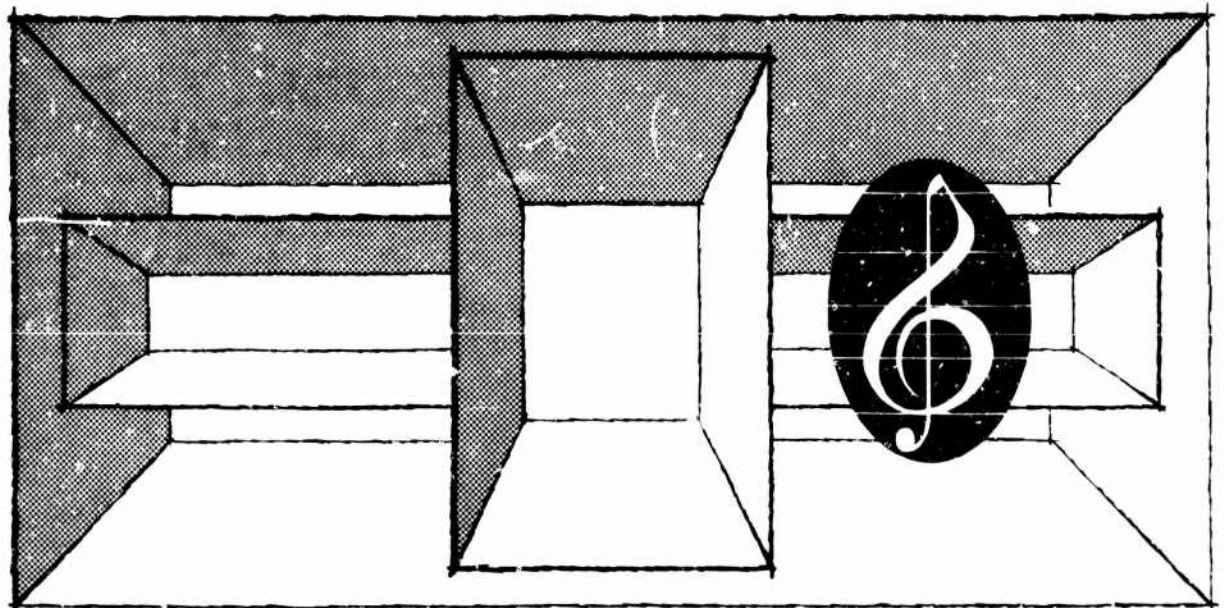
786

Istituto Nazionale di Ottica, Florence (Italy).

BLUE-GREEN RESPONSES AT MESOPIC LUMINANCES, by L. Ronchi. [1959] [8]p. incl. diagrs. (AFOSR-TN-59-1136) (AF 61(052)80) AD 232081 Unclassified

Also published in Atti Fondazione G. Ronchi, v. 14: 384-391, July-Aug. 1959.

As suggested by a working hypothesis concerning the retinal mechanisms, some experiments (both electroretinographic and psychophysical) were performed in order to study the response of the eye when, in the mesopic range of luminances, blue and green lights impinge contemporaneously on the retina. Expectations were fulfilled and the decrease of both probability of contrast perception and height of the b-wave was tested when some blue radiation was added to green, or vice versa. The results emphasized are: (1) At low levels the electroretinographic response, with decreasing luminance, decreases more rapidly in the case of blue-green stimulation than either blue or green stimulation. (2) The electroretinographic response to either blue or green stimulation does not show a smooth decrease with decreasing luminance. (3) The electroretinographic response is less pronounced after the adaptation to a green field than after adaptation to a blue-green field. (4) The probability of perception of limited contrast, at mesopic levels, under blue or green stimulation follows a complex behavior. (5) The addition of some blue light to a green field decreases the probability of perception of contrast.



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James Forrestal Research Center, Princeton, N. J.
see Princeton U. James Forrestal Research Center,
N. J.

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Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

PLASMA DYNAMICS, by F. H. Clauser. Final rept.
Aug. 1959, 75p. incl. diagrs. (AFOSR-TR-59-125)
(AF 18(600)671) AD 229510; PB 144732 Unclassified

Also published in Proc. Durand Centennial Conf. on
Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-
8, 1959), New York, Pergamon Press, 1960, p. 305-
343. (AFOSR-TR-59-108)

The 1-dimensional, steady flow of a gas consisting of
particles all having the same sign of their electrical
charge is explored. The question of what dynamical
equations govern such a flow is discussed, and these
equations are solved without sacrificing their nonlinear
character. The full range of behavior from zero Mach
number to infinite Mach number is explored as is the
full range of the effect of external electric fields on the
flow. It is found that the non-linearity of the equations
introduces several fundamental new concepts to fluid
mechanics. It is also found that under some conditions
a number of radically different flows can exist for
exactly the same set of boundary conditions. Under
other conditions, no flows whatever exist that fit the
boundary conditions. (Contractor's abstract)

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Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

VELOCITY AND TEMPERATURE FLUCTUATION
MEASUREMENTS IN A TURBULENT BOUNDARY
LAYER DOWNSTREAM OF A STEPWISE DISCONTI-
NUITY IN WALL TEMPERATURE, by D. S. Johnson.
[1959] [12]p. incl. diagrs. refs. (AF 18(600)671)
AD 240304 Unclassified

Presented at annual meeting of the Amer. Soc. of Mech.
Engineers, New York, Nov. 30-Dec. 5, 1958.

Also published in Jour. Appl. Mech., v. 26: 325-336,
Sept. 1959.

Results are presented of an experimental investigation
of the coexisting thermal and velocity fluctuation fields
in a turbulent boundary layer downstream of a small
stepwise discontinuity in wall temperature. The statis-
tical behaviors of several relevant fluctuating quantities
were obtained at a typical cross section of the boundary
layer in the region where the thermal boundary layer
has not yet reached the free stream. The instantaneous
surface of demarcation between heated and unheated
fluid was found to be sharp and distinct at all points,
resulting in intermittent temperature fluctuation signals
well within the fully turbulent region of the momentum

boundary layer. From the measurements at 1 section,
the balances of turbulent kinetic energy and of turbulent
temperature fluctuations across the boundary layer have
been evaluated. In addition, the distribution of the local
turbulent Prandtl number (ratio of the turbulent diffu-
sivities of momentum and heat) through the boundary
layer was obtained; it is not constant and varies between
limits of 0.8 and 1.2. (Contractor's abstract)

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Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

ON SUPERSONIC WIND TUNNELS WITH LOW FREE-
STREAM DISTURBANCES, by M. V. Morkovin. [1959]
[6]p. incl. diagr. refs. (Sponsored jointly by Air Force
Office of Scientific Research under [AF 18(600)1121]
and Office of Naval Research) Unclassified

Presented at summer Conf. of Appl. Mech. Div., Amer.
Soc. Mech. Engineers, Troy, N. Y., June 18-20, 1959.

Published in Jour. Appl. Mech., v. 26: 319-324, Sept.
1959.

Measurements in supersonic wind tunnels have become
almost routine in the last decade and yet little is known
about the free-stream disturbances, which are present,
and about the means of minimizing them. The present
note outlines the problems of minimizing the mean as
well as the unsteady variations of velocity and tempera-
ture and gives guidance where the trends are clear. It
is found that in many wind tunnels the free-stream fluc-
tuations are likely to be dominated by aerodynamic
sound in the sense of Lighthill and by shivering Mach
waves. Only conjectures can be offered on the means of
minimizing the resulting sound intensity at the present
time. (Contractor's abstract)

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Johns Hopkins U. Dept. of Aeronautics, Baltimore, Md.

ANOTHER UNSTEADY TURBULENT BOUNDARY
LAYER, by H. Tennekes. May 1959 [43]p. incl. diagrs.
refs. (AFOSR-TN-59-600) (AF 49(638)496) AD 217177;
PB 142245 Unclassified

An investigation of a zero mean pressure gradient tur-
bulent boundary layer, subjected to sinusoidal free stream
oscillations, was undertaken by S. K. F. Karlsson
(Johns Hopkins U., Dept. of Aeronautics, 1958). It was
found that this boundary layer responded, within experi-
mental scatter, linearly. A comparison was made of
Karlsson's data with the results of Lighthill (Proc. Roy.
Soc., v. 224A: 1-23, June 1954) for the corresponding
laminar layer. Linearity of response being a remarkable
feature, it was decided to subject the boundary layer to
another free stream transient. A simple step function
type transient was chosen. A preliminary discussion of
the response of a turbulent boundary layer to this tran-
sient is given. A simple electronic analog computer

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for linear synthesis of the response of the boundary layer to free stream transients, based on Karlsson's data, is discussed. (Contractor's abstract)

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Johns Hopkins U. [Dept. of Aeronautics] Baltimore, Md.

A THEORY OF NEARLY LINEAR SYSTEMS, by F. H. Clauser. [1956] [75]p. incl. diagrs. (AFOSR-TN-59-1133) (AF 49(638)496) AD 229276; PB 144779

Unclassified

Presented at First Internat'l. Conf. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 1: 218-232, 1960.

A theory is developed which permits the usual concepts of impedance and admittance to be applied to nonlinear systems, but the impedances and admittances now become matrices whose components give not only the response to the multiple frequencies that are present in nonlinear systems, but also the intercoupling of these frequencies as well. Numerous examples are used to show that the method can treat a wide variety of problems such as subharmonic and superharmonic resonance, oscillator lock-in, parametric amplification, superregeneration, rectification, modulation and the like. (Contractor's abstract)

792

Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

A PHYSICO-CHEMICAL STUDY OF THE SYSTEM DIPHENYLMETHANE-DIPHENYL ETHER, by R. H. Dettre. [1959] [18]p. incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-59-309) (AF 18(600)765) AD 213241

Unclassified

Also published in Jour. Phys. Chem., v. 64: 67-70, Jan. 1960.

Freezing point, density, viscosity and refractive index values are reported for the system diphenylmethane-diphenyl ether over the entire range of composition. Activity coefficients, volume changes on mixing and excess free energies of mixing have been calculated. The volumes of mixing are compared with those calculated from the excess free energies of mixing. The experimental fluidities are compared with those obtained from various theoretical considerations. The results show that the system exhibits slight negative deviations from ideal behavior. (Contractor's abstract)

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Johns Hopkins U. [Dept. of Chemistry] Baltimore, Md.

DEVELOPMENT OF AN AUTOMATIC METHOD FOR THE DETERMINATION OF HEAT CAPACITIES OF ORGANIC LIQUIDS AND THEIR RECORDING ON PUNCH CARDS, by D. H. Andrews. Final rept. June 1, 1953-May 31, 1959. June 1959, 20p. incl. refs. (AFOSR-TR-59-71) (AF 18(600)765) AD 218785

Unclassified

A calorimeter was developed with automatic recording and computing equipment. The calorimeter was designed to operate normally with continuous heating but with the possibility that measurements could be made with a discontinuous heating method for comparing the 2 patterns of precision. The adiabatic control consists of a single junction and a simple heating coil on a thermal shield. The single junction provides an electrical potential which is amplified and recorded on a continuous strip-chart recording potentiometer. The recording pen controls a servomechanism for regulating the heat to the adiabatic shield. The necessary data are automatically prepunched on IBM cards which are later collected and fed into a computer. The computer makes the necessary calculations and prints a table of heat capacity/mol as a function of mean temperature of each interval.

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Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

IODINE NQR SPECTRUM OF BORON TRIIODIDE, by W. G. Laurita and W. S. Koski. [1959] [11]p. incl. refs. (AFOSR-TN-59-191) (AF 18(600)1526) AD 260255

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 3179-3182, July 5, 1959.

Consideration is given to the experimental measurement of the quadrupole coupling constant (eQq_{zz} in which e is the proton charge) and the asymmetry parameter (N), and their relation to the nature of the chemical binding in BI_3 . Comparison is also made with the corresponding parameters in the other boron trihalides.

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Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

MECHANISMS OF ISOTOPIC EXCHANGES IN THE BORON HYDRIDES, by W. S. Koski. June 1959 [18]p. incl. diagrs. tables, refs. (Technical note no. 11) (AFOSR-TN-59-613) (AF 18(600)1526) AD 217400; PB 142986

Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in *Advances in Chem. Ser.*, No. 32: 78-87, 1961.

Evidence has been accumulated for at least 3 mechanisms by which isotopic exchange proceeds in the boron hydrides. In the diborane self-exchange the reaction appears to involve borane as an entity, and the ratio of deuterium rate to boron rate is 3. In the $B_2D_6 - B_5H_9$ exchange the rate-determining step is the reaction of borane with the terminal hydrogens of pentaborane. The bridge hydrogens are not involved at all. A similar situation exists in the diborane-deca-borane exchange. In the $B_2D_6 - B_5H_{11}$ reaction the fraction-order kinetics indicate that the B_5H_{11} is fragmenting. All of the borons and all of the hydrogens in both molecules are participating in the exchange. Only 1 rate of exchange has been observed, but there is experimental evidence that exchange can proceed by an intramolecular mechanism. In the case of the $B_2D_6 - B_4H_{10}$ reaction 1 has at least 2 mechanisms of isotopic exchange and evidence has been obtained for an exchange that proceeds by an intramolecular mechanism. The intramolecular process is an indication of the lability of the hydrogens and the borons in some of the less stable boron hydrides. (Contractor's abstract)

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Johns Hopkins U. Dept. of Chemistry, Baltimore, Md.

FAR INFRARED SPECTRA OF SOME SYMMETRIC TOP MOLECULES, by D. W. Robinson and D. A. McQuarrie. [1959] [15]p. incl. tables. (AFOSR-TN-59-967) (AF 49(638)468) AD 229729; PB 145308
Unclassified

Also published in *Jour. Chem. Phys.*, v. 32: 556-569, Feb. 1959.

Pure rotational spectra out to 30 cm^{-1} are presented of the gaseous molecules CH_3CN , CH_3CCH , HCF_3 and $(CH_3)_3N$. These spectra are interpreted in the view of the rotational constants previously determined from microwave data. The heretofore undetermined value of D_J for CH_3CN has been estimated to be $1.45 \times 10^{-7}\text{ cm}^{-1}$, the value of D_{JK} for $(CH_3)_3N$ is shown to be positive, and intensity distribution in the high -J subbands of the oblate top, HCF_3 , has been estimated to have its center at $K = 17$. (Contractor's abstract)

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Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

RECENT WORK ON FAMILIES OF PERIODIC SOLUTIONS OF DIFFERENTIAL EQUATIONS, PART I. SINGULAR SOLUTIONS OF SYSTEMS OF REAL ANALYTIC

EQUATIONS, PART II. THE STROMGREN-WINTNER PRINCIPLE ON THE TERMINATION OF FAMILIES OF PERIODIC SOLUTIONS, PART III, by D. C. Lewis, Jr. June 30, 1959, 61p. incl. refs. (AFOSR-TP-59-70) (AF 18(600)665) AD 225355; PB 143151

Unclassified

A comprehensive survey is given of an attempted global theory of perturbation for periodic solutions of systems of differential equations containing a parameter. The systems of differential equations considered are of the form: $dx/dt = f(x, t, \mu)$, where x and f are vectors, and t and μ are real variables. f is always assumed to be at least of class C^1 in x , t , and μ . Various other topics of independent interest related to this theory are also treated. (Contractor's abstract)

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Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

THREE NOTES: 1. ON OSCILLATORS WITH LARGE FREQUENCIES. 2. ON THE RATIO $f(t + cf^{-\alpha}(t))/f(t)$. 3. ON FUNCTIONS REPRESENTABLE AS A DIFFERENCE ON CONVEX FUNCTIONS, by P. Hartman. Feb. 1959, 10p. incl. refs. (Technical rept. no. 9) (AFOSR-TN-59-114) (AF 18(603)41) AD 210399; PB 139939
Unclassified

Note 3 also published in *Pacific Jour. Math.*, v. 9: 707-713, 1959.

On oscillators with large frequencies: Proof is presented of the theorem: If $q(t)$ is continuous for $t \geq 0$, is monotone, $q(t) \rightarrow \infty$ as $t \rightarrow \infty$ and $\log q(t)$ is of regular growth, then all solutions of $d^2x/dt^2 + q(t)x = 0$ tend to 0 as $t \rightarrow \infty$. On the ratio $f(t + cf^{-\alpha}(t))/f(t)$: In the asymptotic integration theory of $\frac{d^2x}{dt^2} \pm f(t)x = 0$, the results proved imply that $\log(f(u)/f(v))/(1 + \int_u^v f^\alpha(s)ds) \rightarrow 0$ as $u, v \rightarrow \infty$ and $\int_u^\infty f^\alpha(t)dt = \infty$ are equivalent to $f(t + cf^{-\alpha}(t))/f(t) \rightarrow 1$ as $t \rightarrow \infty$. On functions representable as a difference of convex functions: Let D, E be open, convex sets in E^m, E^n respectively. Let $y = y(x)$ map D into E and let each component of $y(x)$ be a difference of convex (d.c.) function. Let $g(y)$ be a scalar d.c. function on E . Then $g(y(x))$ is a d.c. function on D , i.e., if $y_1(x), y_2(x)$ are scalar d.c. functions on D , so is the product $y_1(x)y_2(x)$ and the quotient $y_1(x)/y_2(x)$ if $y_2 \neq 0$.

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Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.
ON SPHERICAL IMAGE MAPS WHOSE JACOBIANS

AIR FORCE SCIENTIFIC RESEARCH

DO NOT CHANGE SIGN, by P. Hartman and L. Nirenberg. Mar. 1959, 28p. incl. refs. (Technical rept. no. 10) (AFOSR-TN-59-549) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)-41 and Office of Naval Research under N6ori-20101) AD 216659; PB 144340
Unclassified

Also published in Amer. Jour. Math., v. 81: 901-920, Oct. 1959.

Mappings $p = p(x)$ are considered of an n -dimensional x region into n -dimensional p space with a Jacobian $J(x)$ which does not change sign. A map $p = p(x)$ is called a gradient map if $p(x)$ is locally a gradient. One of the theorems proved, for example, states that a gradient map $p = p(x)$ with a Jacobian which does not change sign is monotone in the sense that the boundary of the image set is contained in the image of the boundary. Analogous results are valid for the spherical image mapping of an n -dimensional hypersurfaces immersed in $(n+1)$ -dimensional Euclidean space. Applications of the results of the first part are discussed; for example, there are obtained an n -dimensional generalization of the Rado (von Neumann) theorem on saddle surfaces, a characterization of complete hypersurfaces of constant zero curvature in Euclidean spaces as cylinders, and, for $n = 2$, properties of the x sets $\text{grad } z(x) = \text{constant}$ if the Hessian determinant of z is identically zero. (Contractor's abstract)

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Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON UNIQUENESS QUESTIONS FOR HYPERBOLIC DIFFERENTIAL EQUATIONS, by J. P. Shanahan. May 1959, 16p. (Technical note no. 11) (AFOSR-TN-59-650) (AF 18(603)41) AD 230932; PB 145568
Unclassified

Also published in Pacific Jour. Math., v. 10: 677-688, 1960.

The uniqueness, existence, and convergence of successive approximations are considered for a solution of an initial value problem, where $z_{xy} = f(x, y, z, z_x, z_y)$ and $z(x, 0)$ and $z(0, y)$ are assigned. Analogues of the Nagumo and Kamke criteria in the theory of ordinary differential equations are obtained. The method employed is related to the arguments used by Viswanatham (J. Amer. Math. Soc., v. 16: 1952) to prove the convergence of successive approximations for ordinary differential equations under conditions similar to those in Kamke's general uniqueness theorem. (Contractor's abstract)

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Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

A LEMMA IN THE THEORY OF STRUCTURAL STA-

BILITY OF DIFFERENTIAL EQUATIONS, by P. Hartman. [1959] 13p. (Technical note no. 12) (AFOSR-TN-59-1106) (AF 18(603)41) AD 230927; PB 145513
Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 610-620, Aug. 1960.

Let T be the local (real) map $T: x^1 = Ax + X(x)$, where A is a constant square matrix with eigenvalues a_j satisfying $|a_j| \neq 0, 1$ and $X(x)$ is of class C^1 for small $|x|$ satisfying $X = o(|x|)$ as $x \rightarrow 0$. A topological map $R: u = u(x)$ of a vicinity of $x = 0$ onto a vicinity of $u = 0$ is shown such that RTR^{-1} is the linear map $u^1 = Au$. This result is then used to show that if, in the system of differential equations (*) $x' = \Gamma x + F(x)$, Γ is a square matrix with eigenvalues γ_j satisfying $\text{Re } \gamma_j \neq 0$, $F(x)$ is of class C^2 for small x , and $F(x) = o(|x|)$ as $|x| \rightarrow 0$, then there exists a topological map $R: u = u(x)$ of a vicinity of $x = 0$ onto a vicinity of $u = 0$ mapping solution paths of (*) onto those of the linear system $u' = \Gamma u$.

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Johns Hopkins U. [Dept. of Mathematics] Baltimore, Md.

ON LOCAL HOMEOMORPHISMS OF EUCLIDEAN SPACES, by P. Hartman. [1959] 28p. incl. refs. [Technical note no. 13] (AFOSR-TN-59-1107) (AF 18(603)41) AD 230963; PB 145514
Unclassified

Presented at Symposium on Ordinary Differential Equations, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 220-241, 1960.

A system of real ordinary equations near an equilibrium point is studied. The normal form for a local homeomorphism $T: x^1 = Ax + X(x)$ of a vicinity of $x = 0$ into a vicinity of $x^1 = 0$ is considered where A is a constant matrix with eigenvalues a_1, \dots, a_N ; where $|a_j| \neq 0, 1$ and $X(x)$ has uniformly Lipschitz continuous partial derivatives which vanish at $x = 0$. The main result is to the effect that if the linear part of T is a contraction, that is, if $0 < |a_j| < 1$ for $j = 1, \dots, N$, then there exists a C^1 map $R: x \rightarrow u$ such that RTR^{-1} is the linear map $u^1 = Au$. No algebraic conditions are imposed on the a_j . R is constructed in several steps: each step corresponds to a distinct number in the set $|a_1|, \dots, |a_N|$ and involves the introduction of an invariant manifold and successive approximations. The main result remains correct if the assumption that T is a contraction is replaced by the assumption that the numbers less than 1 in the set $|a_1|, \dots, |a_N|$ are "nearly equal" and that those greater than 1 are

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"nearly equal." An example shows that, in general, the main result can be false if $N = 3$ even if T is analytic (if it is only assumed that $|a_j| \neq 0, 1$). (Contractor's abstract)

803

Johns Hopkins U. Dept. of Mathematics, Baltimore, Md.

ON LOCAL AND GLOBAL PROPERTIES OF CONVEX SETS AND HYPERSURFACES, by R. Sacksteder. Nov. 1959 [43]p. incl. refs. (Technical note no. 14) (AFOSR-TN-59-1294) (AF 18(603)41) AD 231782; PB 145774
Unclassified

In the 1st chapters, there is obtained a generalization of a theorem of Tietze characterizing convex sets by local properties. This result is used in the 2nd chapter to prove the main result: Let S be a (sufficiently smooth) isometric immersion of a complete n -dimensional

Riemannian manifold M^n in a Euclidean space E^{n+1} with the intrinsic property that the 2nd fundamental form of S is semi-definite at every point and definite at some point. Then S is the boundary of a convex body

(although if M^n is not complete, S need not even be locally convex). The 3rd chapter deals with a number of topics. Examples are given to show that theorems of Hilbert and Weyl, concerning extrema of principle curvatures or of mean and Gauss curvatures at non-umbilic points, are false without suitable smoothness assumptions. (Contractor's abstract)

804

Johns Hopkins U. Dept. of Mechanical Engineering, Baltimore, Md.

PROBABILITY DENSITY MEASUREMENT WITH AN ELECTRODE MOUNTED IN THE FACE OF A CATHODE-RAY TUBE, by H. Lien. [1959] [3]p. incl. diags. (AFOSR-TN-59-992) (AF 49(638)248) AD 235193
Unclassified

Also published in Rev. Scient. Instr., v. 30: 1100-1102, Dec. 1959.

A small electrode mounted inside the face of a cathode-ray tube gives a window comparable to its own dimensions when the bias voltages are set so that secondary electron emission current dominates. Under these conditions the device can be used for measurement of probability densities of random signals. (Contractor's abstract)

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

RECOMBINATION BETWEEN ELECTRONS AND

HELIUM MOLECULAR IONS (Abstract), by D. E. Kerr and C. S. Leffel, Jr. [1959] [1]p. [AF 18(600)363]
Unclassified

Presented at Eleventh Annual Gaseous Electronics Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 113, Mar. 6, 1959.

Simultaneous measurements of electron density in and radiation from the decaying plasma following a pulsed discharge in helium has permitted identification of the principal ion as He^+ at pressures below about 3 mm Hg, and He_2^+ above 3 mm. At the higher pressures, the radiation is predominantly from the He_2 molecule, and is believed to result from recombination between electrons and He_2^+ ions. Although under these conditions diffusion represents the predominant electron-loss mechanism, an upper limit can be set for the total recombination coefficient, which we believe to be considerably less than $10^{-8} \text{ cm}^3/\text{sec}$. Absolute light intensity measurements permit estimates of a lower limit of recombination coefficient, which are found to be about $3 \times 10^{-10} \text{ cm}^3/\text{sec}$. This range is considerably smaller than has been reported by others. Detailed investigation of emitted light as a function of pressure and electron density permits comparison of several recombination mechanisms and discussion of the effects of collision quenching of excited states. The central question, still not satisfactorily resolved, concerns the mechanism of formation of these states.

806

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

THE USE OF S-MATRIX POLES IN THE DETERMINATION OF PARITIES, by G. Feldman and T. Fulton. May 11, 1959 [7]p. incl. diags. (AFOSR-TN-59-421) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)143 and National Science Foundation) AD 214142
Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 64-66, July 1, 1959.

Recently it has been conjectured (S. Madelstam, Phys. Rev., v. 112: 1344, 1958) that there exist dispersion relations in momentum transfer variables. It has been suggested that an approximation to these relations could be used in order to determine such physical quantities as parities, coupling constants, etc. This approximation consists of extracting the contribution of certain single particle intermediate states to S-matrix elements, and analyzing the experimental data on the assumption that these contributions predominate. Some potential difficulties inherent in such an analysis are pointed out.

807

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

K⁻ ABSORPTION IN HELIUM. I. (Abstract), by J. Leitner, E. M. Harth and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission, and Office of Naval Research) **Unclassified**

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 25, Jan. 28, 1959.

The Duke U. liquid helium bubble chamber was exposed to a low energy K⁻-beam at the Berkeley bevatron. The chamber is situated in a magnetic field of 14.3 kilogauss. In about 90,000 pictures we observed about 9,000 K⁻-mesons of which about 2500 were stopped in the chamber. The following features of the K⁻-helium interaction are being studied: (1) the neutral to charged hyperon production ratio, (2) relative numbers of Λ^0 's produced both directly and by $\Sigma^0 - \Lambda^0$ conversion, (3) angular correlations in Λ^0 decay, pertinent to the question of parity conservation in Λ^0 production, (4) hyperfragment production rates. Preliminary scanning shows that Λ^0 production predominates over charged Σ production; this is expected from the large $\Sigma^0 - \Lambda^0$ conversion observed in K⁻ absorption in deuterium.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

K⁻ ABSORPTION IN HELIUM. II. RELATIVE K⁻- Λ PARITY (Abstract), by A. Pevsner, F. Anderson and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission, and Office of Naval Research) **Unclassified**

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 25, Jan. 28, 1959.

In the Duke helium bubble chamber K⁻ exposure described above preliminary evidence has been found for the existence of a Λ He⁴ hyperfragment. The interpretation of the event as $K^- + He^4 \rightarrow \Lambda He^4 + \pi^-$ is based on the observation of a stopping K⁻-meson from which emerges a π^- of momentum 252 ± 12 mev/c collinear ($\pm 2^\circ$) with a stub of range 0.62 ± 0.08 cm. Kinematic calculations lead one to expect a π^- -momentum of 257 mev/c and a stub of range 0.60 cm. Details of the measurement will be discussed as well as some low probability sources of ambiguity. The existence of the reaction $K^- + He^4 \rightarrow \Lambda He^4 + \pi^-$ has bearing on the relative

K⁻ - Λ^0 parity if it is assumed that parity is conserved in the reaction, that all particles in the reaction have spin 0, and that no bound excited states of the ΛHe^4 exist. Under these assumptions existence of the above reaction would lead to the assignment of negative relative parity of the K⁻ and Λ^0 . The foregoing assumptions and conclusions will be discussed more fully.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

CONTRIBUTION OF A CONSERVED VECTOR CURRENT TO THE β - γ ANGULAR CORRELATION FROM INNER BREMSSTRAHLUNG IN β DECAY (Abstract), by D. Fivel and T. Fulton. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143] and National Science Foundation) **Unclassified**

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 39, Jan. 28, 1959.

Calculations have been made of the β - γ angular correlation from inner bremsstrahlung in the β decay of B¹² and N¹², assuming a V-A interaction with a conserved vector current. The expected 2 correction terms are found. They are functions of the β and γ energies and of the relative angle. The B¹² and N¹² angular correlations differ only in the relative sign of the correction term proportional to the "weak magnetic moment" of the transition. The ratio of these angular correlations therefore differs from unity by a term proportional to the "weak magnetic moment." Due to the contributions of the meson cloud, this moment is $\sqrt{2}$ times the magnetic moment of the corresponding γ transition in C¹² if charge independence is assumed. For photons above 5 mev the ratio differs from unity by more than 0.07. Detailed results of the calculations will be presented. Coulomb, relativistic, and nuclear bremsstrahlung corrections will also be discussed.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

RADIATIVE DECAYS OF THE PION (Abstract), by L. E. Evans. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143] and National Science Foundation) **Unclassified**

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 39, Jan. 28, 1959.

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The discovery of the decay $\pi \rightarrow e + \nu$ with approximately the predicted abundance still leaves unsettled the question of the general nature of the interaction responsible for pion decay. Both a direct pion-lepton coupling and an intermediate coupling via the V-A four-fermion

interaction give a branching ratio of 12.7×10^{-5} for electron decay relative to muon decay. The decay

$\pi \rightarrow \mu + \nu + \gamma$, about 10^{-4} as probable as the nonradiative process, was investigated in an attempt to find effects which distinguish between these 2 coupling schemes. Matrix elements were obtained by invariance arguments similar to those of Treiman and Wyld. Energy spectra, angular correlations, and polarization effects will be discussed.

811

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

DECAY OF K^- MESONS (Abstract), by C. Meltzer, M. M. Block and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 288, Apr. 30, 1959.

Exposures of the Duke U. helium bubble chamber to the slow K^- beam of the Berkeley bevatron have been scanned for K^- decays in flight. A preliminary sample has yielded to date about 300 K^- decays among a total of about 3000 K^- traversals of the chamber. The observed τ branching ratio of about 5% is in good agreement with the K^+ results. Data on other branching ratios and lifetime of the K^- will be presented.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

PRELIMINARY RESULTS REGARDING HIGH ENERGY INTERACTIONS OF π^- IN A He-BUBBLE CHAMBER, by M. [M.] Block, [E.] B. Brucker and others. [1959] [2]p. [AF 18(603)143] Unclassified

Presented at Conf. of the Italian Phys. Soc., Palermo, Nov. 6-11, 1958.

Published in Nuovo Cimento, Series X, v. 12: 642-643 June 16, 1959.

Interactions of 1.1, 1.8, and 2.4 gev/c negative pions with He have been studied at Duke U. with the aim of

determining the relative and absolute parities of K^+ and K^0 . Preliminary results gave a value of 110 mb for the total interaction cross section of 1.8 gev/c negative pions. The cross sections for elastic scattering and for ν^0 production were about 5 and 1 mb, respectively. From the 1st diffraction minimum of the scattering distribution, a value of 2×10^{-13} cm was obtained for the nuclear radius of He. The total interaction cross section of 1.1 gev/c negative pions on He was about 135 mb.

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Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

OBSERVATION OF He^4 HYPERFRAGMENTS FROM K^- -He INTERACTIONS. THE K^- - Λ RELATIVE PARITY, by M. M. Block, E. B. Brucker and others. [1959] [2]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143], Atomic Energy Commission, and Office of Naval Research) Unclassified

Published in Phys. Rev. Lett., v. 3: 291-292, Sept. 15, 1959.

The Duke U. helium bubble chamber was exposed to a separated low-energy K^- beam. Approximately 2500 K^- interactions at rest were obtained. In a partial scan, evidence was found for the production of He^4 hyperfragments in the reaction of $K^- + He^4 \rightarrow He^4 + \pi^-$. The relative K^- - Λ parity can be inferred from the reaction if it is assumed that parity is conserved, the spins of K^- and Λ are zero, and no bound excited states of Λ exist. The K^- - Λ relative parity was established to be negative.

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Johns Hopkins U. Dept. of Physics, Baltimore, Md.

CLASSICAL RADIATION FROM A UNIFORMLY ACCELERATED CHARGE, by T. Fulton and F. Rohrlich. [1959] [19]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)143] and National Science Foundation) Unclassified

Published in Ann. Phys., v. 9: 499-517, Apr. 1960.

The old and much-debated question, whether a charge in uniform acceleration radiates, is discussed in detail and its implications are pointed out. Many contradictory statements in the literature are analyzed and those answers which can be given on the basis of the

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standard classical Maxwell-Lorentz equations are presented. Although the questions that remain open are difficult and fundamental, some simple results can be proved: Contrary to claims in some standard sources (Pauli, von Laue), a charge in uniform acceleration does not radiate. The radiation rate is finite, invariant, and constant in time in the instantaneous rest system. There is no contradiction of this fact with either the principle of conservation of energy or the principle of equivalence. Finally, the group of conformal transformations is found to be not physically meaningful. (Contractor's abstract)

815

Johns Hopkins U. [Dept. of Physics] Baltimore, Md.

MONOCHROMATICALLY EXCITED FLUORESCENCE IN RARE EARTH SALTS, by F. Varsanyi and G. H. Dieke. [1959] [5]p. incl. illus. diags. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)535] and Atomic Energy Commission) Unclassified

Published in Jour. Chem. Phys., v. 31: 1066-1070, Oct. 1959.

Monochromatic excitation, continuously variable in wavelength, makes it possible to analyze in detail the excitation of the fluorescence spectra of rare earth salts. This is a very sensitive method for studying the coupling of the electronic levels with the lattice vibrations. When a crystal contains several kinds of rare earth ions their fluorescence spectra are excited independently of each other. (Contractor's abstract)

816

Johns Hopkins U. [Dept. of Physiology] Baltimore, Md.

RECEPTIVE FIELDS OF SINGLE NEURONES IN THE CAT'S STRIATE CORTEX, by D. H. Hubel and T. N. Wiesel. [1959] [18]p. incl. diags. refs. (AF 49(638)-499) Unclassified

Published in Jour. Physiol. (London), v. 148: 574-591, Oct. 1959.

Recordings were made from single cells in the striate cortex of lightly anesthetized cats. The retinas were stimulated separately or simultaneously with light spots of various sizes and shapes. In the light-adapted state, cortical cells were active in the absence of additional light stimulation. Receptive fields were usually divided into mutually antagonistic excitatory and inhibitory regions. A light stimulus covering the whole receptive field was relatively ineffective in driving most units, owing to the mutual antagonism between these 2 regions. It was found that a spot of light often gave greater and stronger responses for some directions of movement than for others. In some units these asymmetries could be interpreted in terms of receptive

field arrangements. In a binocular unit, excitatory and inhibitory regions of the 2 receptive fields interacted and summation and mutual antagonism could be shown just as within a single receptive field.

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Johns Hopkins U. [Inst. for Cooperative Research] Baltimore, Md.

SHOCK WAVE-TURBULENCE INTERACTION, INVESTIGATIONS IN A SHOCK TUBE, by J. E. Werner. Final rept. May 1959 [134]p. incl. diags. refs. (AFOSR-TR-59-46) (AF 18(600)757) AD 214847; PB 142303

Unclassified

Various aspects of the shock-turbulence interaction problem were investigated analytically and experimentally. The model of a cellular vortex field with a discrete front convected through a shock wave was studied theoretically. Expressions were derived for the unsteady pressure disturbance on the downstream face of the shock, and the displacement of the shock wave itself as the vortex field is carried through it by the mean flow. The interaction of a shock with a random velocity fluctuation field was also considered. The relationship between pressure fluctuation and shock displacement was explored. In particular the pressure fluctuation level is found to depend on shock displacement, turbulence scale, and turbulence intensity. Techniques for measuring these 3 quantities in a shock tube are the subject of the experimental work. The constant temperature hot-wire anemometer was used to measure turbulence intensity, spectra and scale, while shock displacement measurements were made with the aid of shadow-graph pictures. A comparison was made between measured and theoretically derived shock displacement, and order of magnitude agreement is found. (Contractor's abstract)

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Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

LAMELLAR GRATING FAR-INFRARED INTERFEROMETER, by J. Strong and G. A. Vanasse. [1959] [6]p. incl. illus. diags. table. (AFOSR-TN-59-696) (AF 18-(600)1307) AD 248846 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 50: 113-118, Feb. 1960.

A new variable-groove-depth grating-type interferometer that was used to obtain experimental interferograms and spectra for short and long wavelengths ($\lambda < 15 \mu$ to $\lambda > 4\text{mm}$), together with its construction and performance is described. (Contractor's abstract)

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Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

INTERFEROMETRIC SPECTROSCOPY IN THE FAR INFRARED, by J. Strong and G. A. Vanasse. [1959] [7]p. incl. diagrs. refs. (AFOSR-3645) (AF 18(600)-1307) Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 844-850, Sept. 1959.

Michelson's visibility technique for obtaining spectral distributions interferometrically in the visible region is compared with the new far-infrared interferogram method. The scanning function for the lamellar-grating type interferometric modulator that is used for the far-infrared region has been derived. Its theoretical resolution limit is compared with the spectrum estimate obtained from experimental results with a microwave source. Discrepancies between the derived spectrum estimate, obtained by a finite Fourier series expansion, and the true spectrum are discussed. A simple technique, due to Rayleigh, is invoked to avoid distortion of the spectrum due to the so-called Gibbs phenomenon.

A spectrum of H_2O extending from 8 to 60 cm^{-1} ($\lambda = 1250$ to $167\text{ }\mu$) illustrates the application of Rayleigh's method. (Contractor's abstract)

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Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

FAR INFRARED SPECTRA OF H_2O and H_2S TAKEN WITH AN INTERFEROMETRIC SPECTROGRAPH, by G. A. Vanasse, J. Strong, and E. [V.] Loewenstein. [1959] [2]p. incl. diagrs. (AF 18(600)1307) Unclassified

Published in Jour. Opt. Soc. Amer., v. 49: 309-310, Mar. 1959.

A large (12-in. aperture) interferometric spectrograph, constructed at Johns Hopkins U. for far infrared spectroscopy, is described. The figure of merit for this type of spectrograph is $M = n\lambda_c/f$, where n = no. of grating grooves, λ_c = cutoff wavelength, and f = ratio of collimator focal length to modulator diam. The value of the cutoff wavelength is determined by the lamellar grating's groove spacing and the slit width, and appropriate optical filters must be used to insure that no radiation of shorter wavelength reaches the detector. In the absence of noise, λ_c determines the spacing of the sampling points.

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Johns Hopkins U. [Lab. of Astrophysics and Physical Meteorology] Baltimore, Md.

PURE ROTATION SPECTRA OF HCN AND NH_3 (Abstract), by G. A. Vanasse and E. V. Loewenstein. [1959] [1]p. [AF 18(600)1307] Unclassified

Presented at meeting of the Opt. Soc. Amer., New York, Apr. 2-4, 1959.

Published in Jour. Opt. Soc. Amer., v. 49: 512, May 1959.

Spectra of HCN and NH_3 between 100 and $500\text{ }\mu$, with a resolution of 0.5 wave number, have been obtained with the large interferometric modulator at the Johns Hopkins U. The values of B obtained are compared with the accepted values. The conditions under which the spectra were taken, as well as the instrument and the method of transformation are described.

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Johns Hopkins U. [Lab. of Astrophysics and Physical Meteorology] Baltimore, Md.

FAR INFRARED TRANSMISSION AND OPTICAL CONSTANTS OF QUARTZ AND SAPPHIRE (Abstract), by E. V. Loewenstein. [1959] [1]p. [AF 18(600)1307] Unclassified

Presented at meeting of the Opt. Soc. Amer., Ottawa (Canada), Oct. 8-10, 1959.

Published in Jour. Opt. Soc. Amer., v. 49: 1138-1139, Nov. 1959.

Transmission spectra of several samples of quartz and sapphire have been obtained in the wavelength region beyond $100\text{ }\mu$, using the far infrared interferometric modulator of the Johns Hopkins U. All the samples were plane parallel pieces, and the resulting channel spectra can be analyzed for n and k . With the aid of the work of Williams (Jour. Opt. Soc. Amer., v. 49: 1138, Nov. 1959), the values of the constants may be estimated directly from the interferogram. If the constants do not vary too rapidly across the range investigated, the estimates are quite accurate. One of the quartz samples was the window of the Golay detector, which showed a strong channel spectrum despite the fact that it was in an $f/1$ beam. The interpretation of the sapphire channel spectrum in terms of optical anisotropy is discussed.

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Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

THEORETICAL STUDIES OF INTENSITY, LINE WIDTH

AIR FORCE SCIENTIFIC RESEARCH

AND LINE SHAPE IN RESOLVED INFRARED SPECTRA, by W. S. Benedict. Final rept. Sept. 1, 1955-Aug. 31, 1958, 1v. incl. illus. diagrs. tables, refs. (AFOSR-TR-58-61) (AF 18(600)1557) AD 216657; AD 264224
Unclassified

A number of detailed advances in the understanding of the spectra of NH_3 and H_2O are reported. The most significant are: improved structural constants and harmonic potential constants for ammonia; recognition of numerous new interaction effects in the fine structure of NH_3 bands; a striking case of anomalous intensity in the weak binary combination band $\nu_2 + \nu_4$ of NH_3 ; line width measurements in vibration-rotation bands of NH_3 that are qualitatively in accord with the theory of quasi-resonant collision broadening; absence of asymmetry or shift in NH_3 lines in the infrared region at pressures up to 1 atm; discovery of infrared lines due to H_2O^{18} and H_2O^{17} in the solar spectrum through the terrestrial atm; and calculations of line width for $\text{H}_2\text{O}-\text{N}_2$ collisions that appear capable of providing reliable correlations of experimental absorption data and transmission function for atmospheric water vapor. Several publications emanating from the research performed during this study are included: item no. JHU.19: 001-003, Vol. I; JHU.19:004, 005, 008, 009, Vol II; and item no. 824, Vol. III.

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Johns Hopkins U. Lab. of Astrophysics and Physical Meteorology, Baltimore, Md.

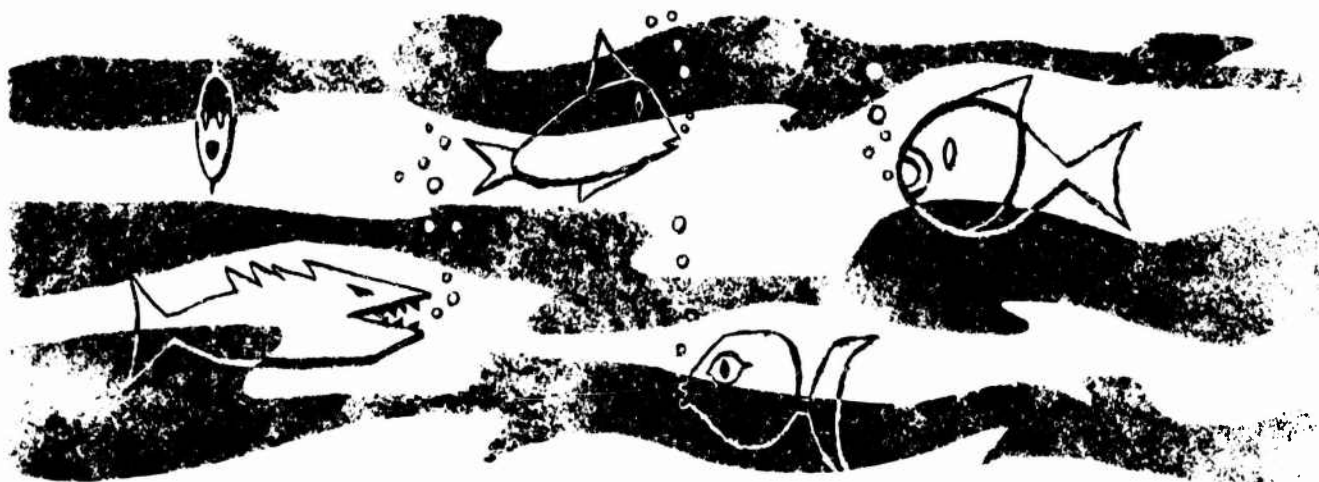
CALCULATION OF LINE WIDTHS IN $\text{H}_2\text{O}-\text{N}_2$ COL-

LISIONS, by W. S. Benedict and L. D. Kaplan. [1959] [12]p. incl. diagrs. tables, refs. (In cooperation with Massachusetts Inst. of Tech., Cambridge) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1557 and Office of Naval Research)
Unclassified

Published in Jour. Chem. Phys., v. 30: 388-399, Feb. 1959.

Anderson's general theory of collision line broadening has been applied to $\text{H}_2\text{O}-\text{N}_2$ encounters. The only attractive force was assumed to be that between the H_2O dipole, $\mu = 1.87 \times 10^{-18}$ esu, and the N_2 quadrupole $q\text{N}_2$, an adjustable parameter. A second adjustable parameter, b_m , the distance of closest approach, includes the effects of all other forces. The IBM 704 was used in the calculation. Effects of varying the parameters were noted for a number of lines, and in the final calculation, which yielded the widths of all significant type B transitions up to $J'' = 13$, parameters $q\text{N}_2 = 2.62 \times 10^{-26}$ esu and $b_m = 3.2\text{\AA}$ which give an exact fit of the observed width of the microwave line $6_{-5}-5_{-1}$, were adopted. The temperature dependence of the line width over the range 220-2400°K, and the effects of vibration-rotation interactions were also calculated. At 300°K widths vary from $0.1115 \text{ cm}^{-1} \text{ atm}$ for $1_{-1}-1_{-1}$ to

$0.03200 \text{ cm}^{-1} \text{ atm}^{-1}$ for $14_{-13}-13_{-13}$, there being a general decrease in width with increasing J, and at a given J, decreasing width with increasing τ . (Contractor's abstract)



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Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

BIOPHYSICAL INVESTIGATIONS OF THE MINERAL PHASE IN HEALING FRACTURES, by U. Nilsson. 1959 [77]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-993) (AF 61(052)15 and AF 61(052)21) AD 227570 Unclassified

Also published in Acta Orthopaed. Scand., suppl. no. 37: 5-81, 1959.

The present work is a study at microscopic and ultra-structural levels of the mineralization process in experimentally obtained diaphyseal fractures in rats and dogs. The theoretical background to the absorption of monochromatized x-ray radiation in bone and callus tissue is described. It is reported that mineralization, as described in the callus region, starts in the periosteal callus and spreads out over the callus area, exhibiting large local variances in the degree of mineralization in different structures. Mineralized structures spanning the fracture gap were observed in the microradiograms considerably later than the macro x-ray pictures gave reason to suppose. Mineralization, which was quite consistent with the observed distribution of bone salt during the development of the callus, proceeds most rapidly during the 1st weeks of the fracture healing period and swifter in the periosteal callus near the fracture ends than in the callus area. The x-ray crystallographic investigation shows that the bone salt occurs as hydroxyapatite in every stage of the development of the callus. The autoradiographic studies with isotope Sr^{90} show that the isotope has the greatest affinity to the least mineralized callus areas, and the significance of this fact is so discussed.

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Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

DETERMINATION OF STRONTIUM IN BONE BY X-RAY FLUORESCENCE SPECTROSCOPY, by G. Högglund. [1959] [5]p. incl. diagr. tables, refs. (AFOSR-TN-59-1007) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)15 and National Institutes of Health) Unclassified

Also published in Exper. Cell Research, v. 17: 565-569, 1959.

A method is described for determination of strontium in bone by x-ray fluorescence. The strontium content of various human bones was determined and found to average about 100 parts per million, which is comparable with values obtained by other investigators using more complicated procedures. No significant difference was found in the strontium content between tibiae and vertebrae nor between sexes. The method described

is accurate, simple, and rapid and extremely well suited for the determination of strontium in bone. Fallout of radio-active fission products from nuclear weapon testing has focused attention upon the concentration of strontium-90 in bone and the hazards inherent in this process. Investigations aimed at evaluating and reducing this hazard require an accurate procedure for determining strontium in bone. Simplicity and rapidity of analysis would be added advantages. (Contractor's abstract)

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Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

RESEARCH REPORT FOR 1958, by A. Engström. [1959] [17]p. (AFOSR-TN-59-340) (AF 61(052)21) AD 264326; PB 143071 Unclassified

An account of the scientific activity under the above contract is reported. The larger part of this report deals with the development of techniques and their applications to the study of the fine structure of the central nervous system with the aim to correlate structure and function. Paralleling this area of investigation is a study to formulate certain general theories regarding information transfer in minute structures along with certain metabolic tracer studies. It is the aim of this project to bring together this related data for a composite report.

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Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

DYNAMICAL ASPECTS OF A METHOD IN TRACER KINETICS, by P. E. Bergner. [1959] [10]p. incl. diagrs. (AFOSR-TN-59-341) (Bound with its AFOSR-TN-59-340; AD 264326) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)-21 and National Institutes of Health) AD 213661 Unclassified

Also published in Exper. Cell Research, v. 17: 328-335, May 1959.

The problems of tracer kinetics, particularly non-specified precursor substance situations that require analysis of the entire biological organism, are discussed. For example, how can a substance such as calcium be characterized? It is concluded that the method used, as outlined in this study can only be used upon isolated problems.

829

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

CORRELATING STUDIES ON CORTICAL ACTIVITY

AIR FORCE SCIENTIFIC RESEARCH

AND STRUCTURE, by P. Valleala. [1959] 3p. (AFOSR-TN-59-557) (AF 61(052)21) AD 264125

Unclassified

The cortical activity investigations of this author are reported. Among the results reviewed is the fact that injury potentials are not responsible for the activity recorded. It is also stated that by plotting the integrated activity against depth of microelectrode position typical "potential profiles" of the different cortical regions can be obtained. Plans for future investigations are also mentioned.

830

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

INVESTIGATIONS ON THE EXCITATION MECHANISM IN THE OLFACTORY EPITHELIUM AND ON THE TRANSMISSION PROCESSES IN THE OLFACTORY SYSTEM, by D. Ottoson. [1959] 3p. (AFOSR-TN-59-558) (AF 61(052)21) AD 264124

Unclassified

The mechanisms of olfactory stimulation are examined. It is reported that a great number of odorous compounds were examined and as a measure of their olfactory stimulating efficiency, the magnitude of the receptor potential was recorded. It is found that aliphatic alcohols have increasing stimulating ability up to a certain maximum with increasing chain length. A similar increase exists for aldehydes and ketones, but fatty acids show a less regular relationship. It is also found that the olfactory bulb response is composed of two successive deflections. Plans for future investigations are also included.

831

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

STUDIES ON EXCITATION PROCESSES IN THE INSECT EYE, by C. G. Bernhard and D. Ottoson. [1959] 2p. (AFOSR-TN-59-559) (AF 61(052)21) AD 264126

Unclassified

The opinion that there should be a reduction of the fusion frequency after removal of the optic ganglion in "fast insect eyes" is investigated. It is shown that removal of the ganglion does not change the flickering ability of the retinal cells. These observations would mean that results based on flickering experiments cannot be taken as evidence for an efferent ganglio-retinal influence in the insect eyes.

832

Karolinska Inst. [Dept. of Medical Physics] Stockholm (Sweden).

STUDIES ON THE RELATIONSHIP BETWEEN OLFACTORY

STIMULATING EFFECTIVENESS AND PHYSICO-CHEMICAL PROPERTIES OF ODOROUS COMPOUNDS, by D. Ottoson. [1958] [15]p. incl. diagrs. refs. (AFOSR-TN-59-1006) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)21 and Swedish Medical Research Council)

Unclassified

Also published in Acta Physiol. Scand., v. 43: 167-181, 1958.

The relationship between the olfactory stimulating effectiveness and the chemical and physical properties of a number of odorous compounds were studied. As a measure of the efficiency the magnitude of the slow potential evoked in the olfactory mucosa in the frog was taken. Aliphatic alcohols of equimolar concentrations were found to be increasingly stimulating up to a certain maximum with increasing chain length. A similar increase was also found for aldehydes and ketones while in the series of fatty acids the relation between stimulative effect and chain length was less regular. It was further found that the partial vapor pressures for alcohols of equal stimulating power increase approximately linearly with the saturated vapor pressures. In terms of thermodynamic activities the alcohols of intermediate chain length are equally stimulating while the lower alcohols are less effective. The relationship between the different molecular parameters and the olfactory stimulative power of the studied compounds is discussed and the similarity between the results obtained in the present investigation and those in studies of olfaction in insects is pointed out. (Contractor's abstract)

833

Karolinska Inst. Dept. of Medical Physics, Stockholm (Sweden).

ON THE KERATIN FIBRILS OF THE SKIN. AN X-RAY SMALL ANGLE SCATTERING STUDY OF THE HORNY LAYER, by G. Swanbeck. [1959] [7]p. incl. illus. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)21 and National Institutes of Health)

Unclassified

Published in Jour. Ultrastruct. Research, v. 3: 51-57, Oct. 1959.

The horny layer of the skin was investigated by means of x-ray diffraction. The fibrils of the horny layer were found to be independently scattering and were therefore assumed to be irregularly arranged. Slope- and peak-analysis of the oriented scatter gives a fibril diameter of 260A. The aggregation of 7 tonofibrils into the 260A fibril of the horny layer is considered to be the main step in the keratinization process of the epidermis.

AIR FORCE SCIENTIFIC RESEARCH

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Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

THE RELATIONSHIP OF LATERAL GENICULATE ACTIVITY TO THE ELECTROCORTICOGRAM IN THE PRESENCE OR ABSENCE OF THE OPTIC TRACT INPUT, by G. B. Arden and U. Söderberg. [1959] [7]p. incl. diagrs. refs. (AFOSR-TN-59-637) (AF 61(514)-1033) AD 225484
Unclassified

Also published in *Experientia*, v. 15: 163-169, Apr. 15, 1959.

The hypothesis that almost all the nerve fibers afferent to the lateral geniculate body originate in the retina is tested by recording the activity of the body before, during, and after increasing the intra-ocular pressure to the point where the eye becomes ischemic. It is shown that another afferent pathway, at least as important as the optic tract, exists to the lateral geniculate. There is some evidence that the body contains interneuronal paths.

835

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

THE RELATION BETWEEN THYROID CIRCULATION, UPTAKE OF IODINE AND SECRETION OF THYROID HORMONE IN CATS AND RABBITS, by U. Söderberg. [1957] [2]p. (AFOSR-TN-59-838) (AF 61(514)1083) AD 225483
Unclassified

Also published in *Acta Physiol. Scand.*, v. 42, suppl. 145: 1957.

Arterial and venous blood passing to and from the thyroid gland was measured, sampled, and analyzed for radio-iodine by a scintillation counter in lightly anaesthetized cats and rabbits. It was found that the uptake of iodine is largely proportional to blood flow through the gland. During severe vasoconstriction, which was produced by electrical stimulation, hypothalamic heating, bleeding the animal, nociceptive stimuli, or administration of adrenaline, noradrenaline, vasopressin or ACTH, the A-V difference falls and increases during large dilations. The vasodilation was elicited by heavy doses of thyrotropic hormone or electrical stimulation. The secretion of thyroid hormone seems to follow the secretion or administration of thyrotropic hormone, regardless of the circulation through the gland.

836

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

FAST SUPRASPINAL CONTROL OF MAMMALIAN MUSCLE SPINDLES. EXTRA- AND INTRAFUSAL

CO-ACTIVATION, by R. Granit, O. Pompeiano, and B. Waltman. [1959] [26]p. incl. diagrs. tables, refs. (AFOSR-TN-59-565) (AF 61(052)115) AD 221899
Unclassified

Also published in *Jour. Physiol. (London)*, v. 147: 385-398, Sept. 2, 1959.

The effect of supraspinal stimulation upon the discharge of hindlimb spindle afferents isolated from dorsal roots was investigated in decerebrate or anesthetized cats. Study was also made to determine whether spindles discharge early enough to be activated by α fibers.

837

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

THE EARLY DISCHARGE OF MAMMALIAN MUSCLE SPINDLES AT ONSET OF CONTRACTION, by R. Granit, O. Pompeiano, and B. Waltman. [1959] [37]p. incl. diagrs. refs. (AFOSR-TN-59-566) (AF 61(052)-115) AD 221898
Unclassified

Also published in *Jour. Physiol. (London)*, v. 147: 399-418, Sept. 2, 1959.

Muscle spindle afferents, coming from ankle flexors or extensors (cat) and isolated in thin dorsal root filaments, discharge early in contraction to a shock to the muscle nerve or the severed ventral root. This early discharge was found to consist of 2 components, one appearing in advance of visible contraction, the other one at the foot of the contraction. The properties of the 2 components have been analyzed in 168 spindles and 19 tendon organs.

838

Karolinska Inst. Nobel Inst. for Neurophysiology,
Stockholm (Sweden).

STUDIES OF THE PHYSIOLOGY OF DISTURBANCES OF MOTOR CONTROL, by O. Pompeiano. Final technical rept. Sept. 30, 1959, 8p. (AFOSR-TR-59-161) (AF 61(052)115) AD 232389; PB 146097
Unclassified

The problem of the fast control of mammalian muscle spindles was examined. Consistent afferent driving of the discharge of hindlimb spindle afferents isolated from dorsal roots was obtained by supraspinal stimulation. The initiation of the spindle response in each case was closely related in time to the onset of the evoked contraction, which accompanied afferent driving. It was considered unlikely that spindles were excited by γ motoneurons, but rather mediated by α motoneurons. An early discharge, too early to be caused by γ fibers, was also elicitable from muscle spindle afferents when stimulating muscle nerve or ventral root. This early discharge was found to consist of 2 components, 1

AIR FORCE SCIENTIFIC RESEARCH

appearing in advance of visible contraction, the other, at the foot of the contraction. Study of α types of release in tension-extension diagrams from cat's forelimb extensor muscle (triceps) was made. Post-brachial section of the spinal cord, deafferentation of the contralateral forelimb and cerebellectomy produced mainly a rise of the gain constant as derived from the slope of the curve in the tension-extension diagrams during slow stretch of the muscle. These effects were present in both normal and deafferented forelimbs. However deafferentation of the forelimb in animal released from cerebellar or spinal cord ascending inhibition actually produced a considerable loss of gain, demonstrating that the afferents had activated a subliminal fringe previously sensitized by the operations releasing α neurones. (Contractor's abstract)

839

Karolinska Inst. Nobel Inst. for Neurophysiology, Stockholm (Sweden).

CHANGES IN CEREBRAL BLOOD SUPPLY CAUSED BY CHANGES IN THE PRESSURE DROP ALONG TO THE BRAIN OF THE CAT, by U. Söderberg and N. Weckman. [1959] [13]p. incl. diagrs. (AFOSR-TN-59-560) (AF 61(052)119) AD 253121 Unclassified

Also published in *Experientia*, v. 15: 346-348, Sept. 15, 1959.

The pressure drop in the extra- and intra-cranial portions of the arteries to the cat's brain is sometimes large enough to significantly influence the cerebral blood flow. The fall in blood pressure in the arteries varies with arterial vasomotor activity as well as with changes in blood flow both inside and outside the skull. No evidence for special vasomotor activity in the carotid rete was found. Results show that a reduction in blood flow-through 1 or 2 of these arteries cannot always be satisfactorily compensated for by increased flow in the remaining vessels. As a consequence, signs of depressed cerebral activity appear when the carotid arteries are markedly constricted.

840

Kent State U. Dept. of Physics, Ohio.

WIDE RF LEVEL RF UNIT FOR AN NMR SPECTROMETER, by K. N. Kapur and J. W. McGrath. [1959] [3]p. incl. diagrs. (AFOSR-TN-59-261) (AF 49(638)168) AD 212326 Unclassified

Also published in *Rev. Sci. Instr.*, v. 30: 272-274, Apr. 1959.

An improved rf unit for a nuclear magnetic resonance spectrometer is described. It uses a crystal oscillator for frequency stability and positive feedback from a cathode follower to increase the effective Q of the sample rf coll. This unit provides an rf level range

of 20 μ v to 60 mv with little limitation on extending the range. This allows saturation studies. The circuit is well suited to direct relaxation time measurements. (Contractor's abstract)

341

Kent State U. Dept. of Physics, Ohio.

PROTON MAGNETIC RESONANCE STUDY OF THE STRUCTURE OF POTASSIUM PENTABORATE, by A. A. Silvidi and J. W. McGrath. Apr. 1959 [4]p. incl. diagrs. table, refs. (AFOSR-TN-59-262) (AF 49(638)168) AD 212329 Unclassified

Also published in *J. Chem. Phys.*, v. 30: 1028-1031, Apr. 1959.

The proton magnetic resonance absorption spectrum of monocrystalline potassium pentaborate has been obtained experimentally at room temperature using a Pound-Watkins spectrometer. The results indicate that there are two waters of hydration/molecule. The interproton distance is 1.80 ± 0.02 Å. The p-p axes lie in the b-c plane of the crystal and make an angle of $93^\circ \pm 4^\circ$ with each other. Using experimental data together with consideration of interatomic distances and hydrogen bonding the remaining hydrogens are tentatively located in the molecule. (Contractor's abstract)

842

Kent State U. Dept. of Physics, Ohio.

PROTON MAGNETIC RESONANCE STUDY OF LITHIUM SULFATE MONOHYDRATE, by J. W. McGrath, A. A. Silvidi, and J. C. Carroll. [1959] [6]p. incl. diagrs. tables, refs. (AFOSR-TN-59-397) (AF 49(638)168) AD 232979 Unclassified

Also published in *Jour. Chem. Phys.*, v. 31: 1444-1449, Dec. 1959.

An extended proton magnetic resonance study of lithium sulfate monohydrate is presented. An oddity in the resulting Pake curves appears. Some of the curves show a shift so that they are described by equations of the form, $\Delta H = 2\alpha[3 \cos^2(\phi + \phi_0) \cos^2 \delta - 1] + \text{constant}$ shift. There are 2 orientations of the hydrated water molecule. For these the direction angles of the proton-proton axes with respect to the crystallographic a, b, and c axes are, respectively, $\alpha_0 = 97^\circ$, $\beta_0 = 45^\circ$, $\gamma_0 = 48^\circ$, and $\alpha_0 = 74^\circ$, $\beta_0 = 38^\circ$, $\gamma_0 = 127^\circ$. Apparently the hydrogens bond $O_5 - H - O_5 - H - O_1$, where O_5 are neighboring water oxygens and O_1 is a sulfate oxygen.

Several possible origins of the shifts in the Pake curves are discussed with limited success. An adequate theoretical explanation is lacking. (Contractor's abstract)

843

Kent State U. Dept. of Physics, Ohio.

PROTON MAGNETIC RESONANCE STUDY OF THE STRUCTURE OF BARIUM CHLORIDE DIHYDRATE, by A. A. Silvidi and J. W. McGrath. [1959] [3]p. incl. diagrs. tables. (AFOSR-TN-59-886) (AF 49(638)168) AD 236392 Unclassified

Also published in Jour. Chem. Phys., v. 32: 924-926, Mar. 1960.

The proton magnetic resonance absorption spectrum of barium chloride dihydrate has been obtained experimentally at room temperature using a Pound-Watkins spectrometer. The results indicate that there are 4 pairs of p-p directions in the crystal. The p-p distance and direction angles of these 4 pairs are: 1.58A, $\alpha_0 = 90^\circ$, $\beta_0 = 58^\circ$, $\gamma_0 = 148^\circ$; 1.58A, $\alpha_0 = 90^\circ$, $\beta_0 = 58^\circ$, $\gamma_0 = 32^\circ$; 1.59A, $\alpha_0 = 148^\circ$, $\beta_0 = 58^\circ$, $\gamma_0 = 90^\circ$; 1.57A, $\alpha_0 = 32^\circ$, $\beta_0 = 58^\circ$, $\gamma_0 = 90^\circ$. The experimental error for the p-p distance is $\pm 0.02A$ and for the direction angles it is $\pm 4^\circ$. By using experimental data, x-ray analysis, and the concept of hydrogen bonding the positions of the hydrogen atoms were determined. (Contractor's abstract)

844

Kent State U. [Dept. of Physics] Ohio.

PROTON MAGNETIC RESONANCE STUDY OF THE MONOHYDRATES OF POTASSIUM MERCURIC CHLORIDE AND POTASSIUM STANNOUS CHLORIDE (Abstract), by A. A. Silvidi and J. W. McGrath. [1959] [1]p. (AFOSR-TN-59-1019) (AF 49(638)168) Unclassified

Presented at meeting of the Amer. Phys. Soc., Kent State U., Ohio, Oct. 16-17, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 471, Dec. 28, 1959.

A proton magnetic resonance study has been made of

the monohydrates of potassium mercuric chloride and potassium stannous chloride using a slightly modified Pound-Watkins spectrometer. The results for the mercuric salt are that there are 2 orientations of the p-p axes lying in the crystallographic ab plane and making angles of $\pm 20^\circ 33'$ with the a axis. The average values of both of the p-p separations are $1.59 \pm 0.01A$. The results for the tin salt are that there are 2 orientations of the p-p axes lying in the crystallographic ab plane and making angles of $\pm 38^\circ 10'$ with the a axis. The average values of both of the p-p separations are $1.59 \pm 0.01A$. The method of obtaining these values will be briefly explained. The results will be compared with the previously published information on these compounds.

845

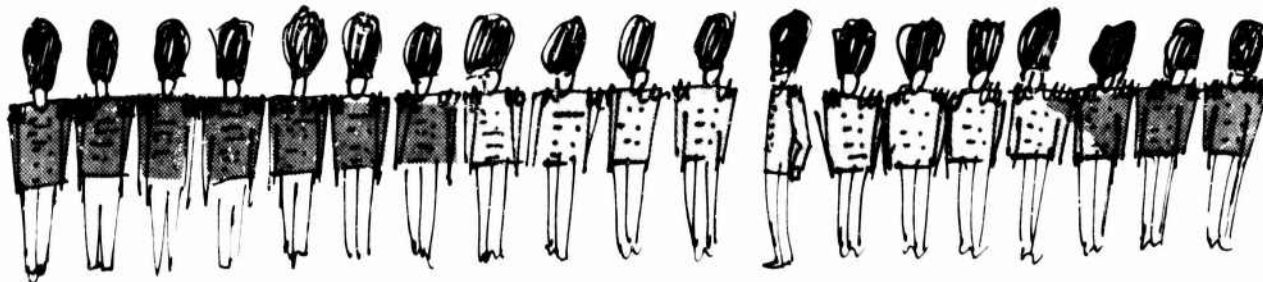
Kentucky U. [Dept. of Physics] Lexington.

FIELD INDUCED SWITCHING CYCLE IN STIBNITE (Abstract), by D. M. Mattox and L. Gildart. [1959] [1]p. (AF 49(638)90) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 228, Apr. 30, 1959.

A stibnite crystal containing about 2% antimony can be made to switch repeatedly between the values of 10^4 and 10^{10} ohms purely by electrical means. Breakdown requires a voltage pulse of about a μ sec duration at fields of the order of 10^3 v/cm as has been described, the crystal then having a resistance of about 10^4 ohms. Restoration of the original resistance, 10^{10} ohms, can be accomplished by means of (a) rf voltage pulses and (b) low-frequency voltage pulses, at fields of about 10^3 v/cm. The time required for restoration is about a msec. Breakdown and restoration thus constitute a complete, electrically induced switching cycle, which is indefinitely repeatable. Other Group V-Group VI compound semiconductors have been examined, but only stibnite containing excess antimony has been found to possess this behavior.



AIR FORCE SCIENTIFIC RESEARCH

Laboratoire Méditerranéen de Recherches Thermodynamiques, Nice (France).
see Méditerranéen de Recherches Thermodynamiques, Nice (France).

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Laval U. Dept. of Chemistry, Quebec (Canada).

STUDY OF CHEMICAL REACTIONS IN THE ELECTRICAL DISCHARGE, by P. A. Giguère. Final rept. Nov. 10, 1959 [7]p. incl. refs. (Technical rept. no. 50) (AFOSR-TR-59-183) (AF 18(600)492) AD 229717; PB 144905 Unclassified

The mechanism by which hydrogen peroxide vapor decomposes upon heating has been established definitely. Above 400°C and at low pressure the reaction proceeds mostly in the gas phase; no long chains are involved, and the critical energy is about 50 kcal. The thermodynamic properties of hydrogen peroxide and its "heavy" analogue D₂O₂ have been computed for temperatures up to 1500°C. These data will be useful in evaluating the performance of that high-energy chemical. A new interesting effect was discovered incidentally: traces of hydrogen peroxide are very efficient in suppressing explosions at the 2nd limit in mixtures of hydrogen-oxygen. Repeated attempts by various methods have failed to reveal the spectrum of the elusive intermediate HO₂. The claim by Russian investigators that a superoxide of hydrogen H₂O₄ can be produced in large concentrations by bombarding condensed ozone with atomic hydrogen was proved to be unfounded. (Contractor's abstract)

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Laval U. Dept. of Chemistry, Quebec (Canada).

REACTION PRODUCTS OF ATOMIC HYDROGEN WITH SOLID OZONE, by P. A. Giguère and D. Chin. [1959] [2]p. incl. refs. (AF 18(600)492) Unclassified

Published in Jour. Chem. Phys., v. 31: 1685-1686, Dec. 1959.

An examination of the glassy substances produced by bombarding liquid ozone with atomic hydrogen for 5 to 200 min is made. The data gathered tends to disprove the claims of a group of Russian investigators (Zhur. Fiz. Khim., v. 30: 2580-2581, Nov. 1956; v. 31: 1843-1850, Aug. 1957) of successfully synthesizing a superoxide of hydrogen H₂O₄ in high concentrations.

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Laval U. Dept. of Physics, Quebec (Canada).

RESEARCH ON THE AUGER ELECTRONS ASSOCIATED

WITH BETA-DISINTEGRATION, by C. Geoffrion. Final rept. Jan. 1956-Aug. 1958. Aug. 21, 1959, 49p. incl. diagr. tables, refs. (AFOSR-TR-59-145) (AF 18(600)1574) AD 227941; PB 144007 Unclassified

The work done under this contract has accomplished the following results. The spectrum of L-Auger electrons from Tl²⁰⁶ and Bi²¹² has been studied in the region extending from 5 to 13 kev; the energy of 37 lines has been determined with a precision varying from 10 to 20 v. This has been realized by using: (a) a carefully calibrated high resolution beta-ray spectrometer; (b) very thin source and source backing; (c) electron acceleration at the Gelger counter, to obtain full transmission by the counter window. The identification of the transition corresponding to each of the measured lines has been done with the help of a new empirical formula for secondary ionization potential. This rule although still empirical - represents a definite improvement over other empirical formulas. A new table of 60 theoretical values for the rates of various K-Auger transitions has been calculated, to replace and complete the incorrect table published 20 years ago by L. Pincherle and used since by many workers. From this new table and from radiative transition rates calculated in the same approximation, K-fluorescence yield values have been obtained that are in better agreement with experimental results than most of the previously published values.

849

Lehigh U. [Dept. of Mathematics] Bethlehem, Pa.

SOME UNIQUENESS THEOREMS ON RIEMANNIAN MANIFOLDS WITH BOUNDARY, by C.-C. Hsiung. [Final rept.] [1959] [15]p. incl. refs. (AFOSR-TR-59-200) (AF 49(638)215) Unclassified

Also published in Illinois Jour. Math., v. 4: 526-540, Dec. 1960.

Theorem I. Let M_n and M_n^* be 2 star manifolds, with boundaries B_{n-1} and B_{n-1}^* respectively, in an Euclidean space E_{n+m} for any $m > 0$. Suppose that there exists an orientation-preserving diffeomorphism f of the manifold M_n onto the manifold M_n^* such that, at each pair of corresponding points, the manifolds M_n and M_n^* have a common fundamental normal frame $e_{n+1} \dots e_{n+m}$ and equal $P_{r, n-1}$ defined by the equation $\sum_{\alpha} \binom{n}{\alpha} P_{r\alpha} = \sum 1/k_{r1} \dots 1/k_{r\alpha} (1 \leq \alpha \leq n)$ and associated with each common unit normal vector $e_r, r = n+1, \dots, n+m$. If the diffeomorphism f restricted to the boundary B_{n-1} is a translation (strictly speaking, is induced by a translation in the space E_{n+m}) carrying the boundary

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B_{n-1} onto the boundary B_{n-1}^* , then the diffeomorphism f is a translation carrying the whole manifold M_n onto the whole manifold M_n^* . Theorem II. Let M_n be a star manifold with a spherical boundary B_{n-1} such that at every point $P_{r, n-2}^\mu P_{r, n-1}^\nu$ is constant for $\mu + \nu > 0$, $\mu \geq 0$, $\nu > 0$ and for each vector e_r of a fundamental normal frame of the manifold M_n . Then the manifold M_n is a compact subset of an n -sphere. Theorem III. Let M_n and M_n^* be 2 oriented convex hypercaps with boundaries B_{n-1} and B_{n-1}^* respectively. Suppose that there exists an orientation-preserving diffeomorphism f of the hypercap M_n onto the hypercap M_n^* such that at each pair of corresponding points the hypercaps M_n and M_n^* have the same outer normal vector and satisfy either $P_1 \leq P_1^*$, $P_2 \geq P_2^*$ or $P_1 \geq P_1^*$, $P_2 \leq P_2^*$ where P_α and P_α^* are defined by the equation in theorem I for the hypercaps M_n and M_n^* respectively. If the diffeomorphism f restricted to the boundary B_{n-1} is a translation carrying the boundary B_{n-1} onto the boundary B_{n-1}^* , then the diffeomorphism f is a translation carrying the whole hypercap M_n onto the whole hypercap M_n^* . The above theorems are proved and discussed.

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Lehigh U. Dept. of Physics, Bethlehem, Pa.

MULTIPOLE SINGULARITIES OF CLASSICAL VECTOR AND PSEUDOVECTOR FIELDS, by P. Havas. May 25, 1959, 45p. incl. refs. (AFOSR-TN-59-479) (AF 18(600)1462) AD 215732 Unclassified

Also published in Phys. Rev., v. 116: 202-217, Oct. 1, 1959.

Forms are established for the multipole moments of arbitrary order compatible with the equations of motion and also of the moments compatible with the more restrictive interactions proposed by Harish-Chandra, which include those of electrodynamics as a special case. These forms are established under the assumption that the spin of the particle is of constant magnitude and has only spatial components in the rest system, and for pure 2^n -pole moments of constant magnitude (intrinsic moments) or of variable magnitude (induced moments, acceleration-dependent forces). The results are generalized on singularities of scalar and pseudoscalar fields, which establish the general form of the intrinsic moments, to show the possibility of induced moments of all orders.

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Leyden U. Lorentz Inst. (Netherlands).

RELATIONS BETWEEN PATH INTEGRALS AND THE VARIATIONAL PRINCIPLES OF HAMILTON, by J. Vlieger, P. Mazur, and S. R. de Groot. July 16, 1959, 7p. (AFOSR-TN-59-959) (AF 61(052)16) AD 226407; PB 146019 Unclassified

Also published in Physica, v. 25. 55-56, Jan. 1959.

Groenewold's representation for the propagation of the Schrödinger equation is shown to lead to the so-called modified Hamilton principle. (Contractor's abstract)

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Leyden U. Lorentz Inst. (Netherlands).

ENTROPY AND GAUSSIAN-MARKOFF PROCESSES, by P. Mazur and S. R. de Groot. July 16, 1959, 15p. (AFOSR-TN-59-960) (AF 61(052)16) AD 226408; PB 146020 Unclassified

The model of Gaussian-Markoff processes is used to discuss the time behavior of entropy. The statistical definitions of entropy of Boltzmann and Gibbs are considered. Under macroscopic conditions, the same behavior as expected from non-equilibrium thermodynamics is shown to be obtained in both cases. (Contractor's abstract)

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Library of Congress. Science and Technology Div., Washington, D. C.

AVIATION MEDICINE: AN ANNOTATED BIBLIOGRAPHY, VOLUME 2, 1953 LITERATURE, by A. J. Jacobius, M. J. Wilkins and others. St. Paul, Aero Medical Assoc., 1959, 354p. incl. refs. (Sponsored jointly by Air Force [Office of Scientific Research] under [MIPR-680-58-8], [Defence Research Board of Canada] and [Office of Naval Research] under NAONR-31-58) AD 207740 Unclassified

This bibliography contains abstracts of 1953 literature covering the following subject areas: (1) history and general aspects of aviation medicine; (2) aviation physiology; (3) pathology and pharmacology of aviation; (4) aviation psychology; (5) preventive medicine and sanitation; (6) special problems in high altitude and space flight; and (7) miscellaneous problems such as survival, rescue, accidents, human engineering, and personnel.

Libre U., Brussels (Belgium).
see Free U. of Brussels (Belgium).

AIR FORCE SCIENTIFIC RESEARCH

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Liège U. (Belgium).

PROBLEMS AND METHODS IN PARTIAL DIFFERENTIAL EQUATIONS. PART III. DIFFERENTIATION OF THE FINITE PART AND OF THE LOGARITHMIC PART OF SOME DIVERGENT INTEGRALS WITH APPLICATIONS TO THE CAUCHY PROBLEM, by F. J. Bureau. Oct. 1959, 89p. incl. refs. (Technical scientific note no. 1) (AFOSR-TN-59-963) (AF 61-052)86) AD 232055; PB 145744 Unclassified

The following topics are discussed: (1) Derivatives of some improper integrals; (2) Finite part and logarithmic part of some divergent integrals; (3) The Cauchy problem for the damped wave equation; and (4) The Cauchy problem for the equation of Euler-Poisson-Darboux.

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Liège U. (Belgium).

ASYMPTOTIC REPRESENTATION OF THE SPECTRAL FUNCTION OF SELF-ADJOINT ELLIPTIC OPERATORS OF THE SECOND ORDER WITH VARIABLE COEFFICIENTS, by F. J. Bureau. Nov. 1959, 77p. incl. refs. (Technical scientific note no. 2) (AFOSR-TN-59-1182) (AF 61(052)86) AD 232050; PB 146716 Unclassified

Also published in Jour. Math. Anal. and Appl., v. 1: 423-483, 1960.

$$\text{Let } L_x = a^{ij}(x) \frac{\partial^2}{\partial x^i \partial x^j} + b^i(x) \frac{\partial}{\partial x^i} + c(x), (i, j =$$

1, ..., n) be a self-adjoint elliptic operator with analytic coefficients and $u_{tt} - L_x u = 0$ the totally hyperbolic equation associated with L_x . The connection between

the elementary solutions of L_x and the hyperbolic equation is described. The solution of the Cauchy problem for the hyperbolic equation is written with classical symbols only. Then the asymptotic behavior is considered of the spectral function $\mathcal{E}(x, y; \lambda)$ of L_x +

$\lambda v = 0$, $x \in D$, and $v = 0$ on D , where λ a parameter, D a bounded simply connected domain of R^n with boundary D . The asymptotic behavior of $\mathcal{E}(x, x; \lambda)$ is shown to depend only on the values of the coefficients of L_x at

the point x and is independent of the boundary conditions. The method applies to other problems in the theory of vibrations when the solution of the corresponding Cauchy problem is written in a suitable form. (Contractor's abstract)

856

Liège U. (Belgium).

RESEARCH IN HYPERBOLIC DIFFERENTIAL EQUA-

TIONS, by F. J. Bureau. Annual summary rept. Mar. 14, 1958-Mar. 15, 1959, 5p. (AFOSR-TR-59-82) (AF 61(052)88) Unclassified

A review of the research to date is briefly described. The objectives of the investigation is 2 fold: (1) Investigate the Cauchy problem for partial differential equations of the order n greater than 2 and p greater than 2 independent variables, (2) Investigate boundary value problems for totally hyperbolic equations in several independent variables. The differentiation of the finite part and of the logarithmic part of some divergent integrals were studied in order to perform the synthesis of the representation formula obtained for the Cauchy problem. A new method was found for finding explicit solutions for the Cauchy problem. To study the boundary problem a preliminary study to determine the asymptotic behavior of the spectral function was necessary. These results have not been published to date.

857

Liège U. Inst. of Astrophysics, Cointe-Schlessin (Belgium).

RESEARCH ON NUCLEAR QUADRUPOLE RESONANCE IN SOLIDS, by J. Duchesne. Final technical rept. Jan. 1959 [68]p. incl. diagrs. tables, refs. (AFOSR-TN-59-24) (AF 61(514)1212) AD 211608; PB 139563 Unclassified

The research on this contract is discussed in the following topics: Detection of pure quadrupole spectra; Nature of chemical bonds; Resonance intensity in mixed crystals; Research in radiation chemistry; Tentative interpretation of radiation resistance; Post effects and oxygen effect; Neutron-irradiated sodium chlorate; and Study of the broadening effect of resonance lines.

858

Liège U. Inst. of Astrophysics, Cointe-Schlessin (Belgium).

NUCLEAR QUADRUPOLE RESONANCE IN IRRADIATED ORGANIC CRYSTALS AND IN A SEMI-CONDUCTOR, PART I. ELECTRON SPIN RESONANCE IN CARBONACEOUS ROCKS, PART II, by J. Duchesne, M. Read, and J. Depireux. Jan. 31, 1960, 32p. incl. diagrs. tables, refs. (Technical scientific note no. 1) (AFOSR-TN-59-1214) (AF 61(052)167) AD 236321; PB 147112 Unclassified

Part I. The intensity of quadrupole lines is used as a method for the study of the damage induced by high energy radiation in solid matter. Thermally treated irradiated compounds, which are thereafter re-irradiated, are especially considered. In this connection, the origin of radioprotection phenomena, and the behavior of the interactions between centers perturbed by irradiation, are studied further. Not only gamma-rays are used, but also x-rays and neutrons. The new method is

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successfully applied to a semi-conductor. Parallel use of quadrupole spectroscopy and electron spin resonance is found highly valuable. Part II. The problem of the genesis of free radicals encountered in coals, brown coals, peats and petroleum is analysed. Two hypotheses concerned with the botanical origin and the effect of natural radioactivity are put forward. Whereas the former does seem to be able to give account of the facts for peats, the latter, combined with the geothermal hypothesis, allows a general solution for this problem. (Contractor's abstract)

859

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

[THE SPONTANEOUS ACTIVITY OF THE CELLS OF THE CENTRAL NERVOUS SYSTEM] L'activité spontanée des cellules du système nerveux central, by J. Schlag. Brussels, Arscia, 1959, 192p. incl. diagrs. refs. (AFOSR-TN-59-839) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)22 and National Center of Anesthesiology) Unclassified

A discussion is given of some of the peculiar features, relevant to the problems of the organization, origin and functions of the spontaneous activity of the central nervous system. An analysis of the patterns of neuronal firing is given. It is verified that mesencephalic units discharge either regularly, randomly or in long bursts. It is shown that the regularly firing neurons are generally unresponsive, whereas irregularly firing neurons are excitable by different stimuli. The reticular formation was noted for its complete absence of neuronal bursts. The electrical stimulation of the thalamic intralaminar nuclei was found to be effective. Justification is given of a severe criticism of the commonly used notions of excitation-inhibition systems.

860

Liège U. Inst. of Experimental Therapeutics, Brussels (Belgium).

[NOTE ON THE POSSIBILITY OF CHARACTERIZING MESENCEPHALIC RETICULAR UNITS BY THEIR SPONTANEOUS ACTIVITY] Note sur la possibilité de caractériser les unités réticulées mésencéphaliques par leur activité spontanée, by J. Schlag, J. Faidherbe, and M. Deliége. [1959] [13]p. incl. diagr. tables, refs. (AFOSR-TN-59-840) (AF 61(052)22) Unclassified

Also published in Arch Internat'l. Physiol. et Biochim., v. 67: 227-239, Apr. 1959.

The spontaneous activity of mesencephalic reticular neurons is recorded with microelectrodes in cats. It is found that units, of which spontaneous discharges succeed each other regularly, are in general not responsive to mechanical or electrical peripheral stimuli or visual and auditory stimuli. This relation is estab-

lished by measuring the spike intervals in recorded samples of spontaneous activity and comparing the statistical distributions of interval values. The significant correlation between the estimation of regularity of firing and the relative responsiveness is further supported by the actual possibility to predict responsiveness or unresponsiveness by the observation of the patterns of spontaneous activity. Two interpretations are proposed and discussed. On the 1 hand, the existence of at least 2 classes of functionally or anatomically differing neurons would explain the results. But, on the other hand, it is pointed out that normal quantitative variations of neuronal excitability in the reticular population would fully account for the described observations. (Contractor's abstract)

861

Little, Arthur D., Inc., Cambridge, Mass.

A TEMPERATURE-REGULATED IGNITION SOURCE, by J. Preston and L. E. Ashman. Jan. 1, 1959, 20p. incl. diagrs. (AFOSR-TN-59-30) (AF 18(603)109) AD 209202; PB 145622 Unclassified

Since the current to maintain a wire at a constant temperature depends largely upon the environment of the wire, the current and the temperature are a means of measuring the properties of that environment. The temperature controller described here is capable of heating a fine wire--of the order of a few mills in diameter to some temperature between 700°C and the melting temperature, and holding the temperature constant to within a few degrees. The detector is a photomultiplier that monitors radiation from the center of the wire; changes in radiation result in compensating changes in the current. The controller responds within a msec to sudden changes in the environment of the wire. This rapid response is useful for detecting the onset of ignition in reactive gases and perhaps for measuring the thermal properties of nonreactive gases. (Contractor's abstract)

862

Little, Arthur D., Inc., Cambridge, Mass.

THE IGNITION OF GASES BY HOT WIRES, by L. E. Ashman. Nov. 15, 1959, 14p. incl. refs. (AFOSR-TR-59-173) (AF 18(603)109) AD 229497 Unclassified

Results are presented of 3 yr study of the ignition of gases by hot-wire sources. The techniques developed to carry out these studies were particularly useful in clarifying much of the confusion related to ignition by small sources. The hot-wire method is useful because within the boundary layer near a hot source, heat is transferred by pure conduction; thus, the theories of Frank-Kamenetsky and Semenov are valid. The theory predicts that the ignition temperature must increase as the size of the source decreases. Anomalies appear, however, when the wire size is reduced beyond a certain point, depending on the composition of the gas. These

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anomalies are apparently caused by the depletion of reactants near the surface of very small sources. Both normal and anomalous effects were observed in the studies. (Contractor's abstract)

863

Litton Industries. Space Research Labs., Beverly Hills, Calif.

RESEARCH PROGRAM ON HIGH VACUUM FRICTION, by S. Hansen. Final rept. Mar. 30, 1959 [149]p. incl. illus. diagrs, tables, refs. (Pub. no. 1623) (AFOSR-TR-59-97) (AF 49(638)343) AD 227352; PB 161116
Unclassified

The program was directed towards the study of surface friction under conditions of high vacuum (10^{-5} to 10^{-6} mm Hg.). The 1st phase dealt primarily with preparations necessary to carry out the experimental effort. The 2nd phase was devoted to the methodical examination of the friction characteristics of a large group of materials. The principal test condition studied was that of the linear motion between 2 dry, clean, unlubricated, flat surfaces. In addition to the measurement program, effort was devoted to the study of the microscopic nature of the actual surface-to-surface contacts. Examination of the results of a single sliding contact between 2 clean, machined surfaces led to the conclusion that each individual contact area was largely point-to-plane. Subsequent point-to-plane studies produced some extremely interesting results. It was found that models could be loaded to yield pressures, and under certain conditions could be made to slide with abnormally low friction forces and without microscopic evidence of wear or surface distortion. This work indicated the existence of 2 modes of contact, 1 of pure sliding and a 2nd of areas undergoing shear. The low-friction, low-wear examples appear to be special cases wherein almost all contact areas are of the 1st type. A theory of friction has been postulated, based principally on the analysis of these tests.

864

Litton Industries. Space Research Labs., Beverly Hills, Calif.

RESEARCH STUDY ON PLASMA ACCELERATION, by G. Fonda-Bonardi. Final rept. Mar. 1, 1958-Sept. 30, 1959 [64]p. incl. illus. diagrs. table, refs. (AFOSR-TR-59-170) (AF 49(638)345) AD 229998; PB 144906
Unclassified

A summary is presented of the principles of operation, design criteria, construction details and instrumentation of a pulsed plasma accelerator. The purpose of the project was twofold: to provide verification of the theory previously developed, and to supply engineering information and design data for further applications of the principles involved. Preliminary experimental results are described which appear to substantiate the theoretical

predictions. A preliminary study of an application of the plasma accelerator to high specific impulse thrust production for propulsion purposes is described. It appears that a favorable efficiency can be obtained. A bibliography on pertinent magnetohydrodynamics research and related subjects is appended. (Contractor's abstract)

865

Litton Industries. [Space Research Labs.] Beverly Hills, Calif.

ELECTROMAGNETIC ACCELERATION OF PLASMA (Abstract), by G. Fonda-Bonardi. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) [AF 49(638)-345]
Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

A description is given of the instrumentation system developed for the evaluation of the performance of the plasma accelerator. Three separate methods are used to gather complementary information: (1) photoelectric transit detection, which provides an indication of the transit of the high velocity plasmoid at selected points in the accelerator tube, as well as a measure of the light output at these points; (2) microwave doppler system, which provides detailed velocity and acceleration information and a measure of the microwave reflectivity of the plasma; and (3) ballistic target, which measures the momentum of the plasmoid, and consequently its mass.

866

Lockheed Aircraft Corp. [Missile System Div., Palo Alto, Calif.]

ANALYSIS OF A SIMPLIFIED MODEL OF SOLID PROPELLANT RESONANT BURNING, by W. Nachbar and L. Green, Jr. [1959] [9]p. incl. diagr. table. (AF 18-(603)146)
Unclassified

Published in Jour. Aero/Space Sci., v. 26: 518-526, Aug. 1959.

A model which has been proposed to describe resonant burning of solid propellants assumes burning under conditions where the burning rate is determined by the rate of heat transfer from gas at flame temperature across a thin boundary film to the propellant surface. An idealized, film-type, heat-transfer mechanism is used. It is shown that if a certain "critical" frequency is present in the frequency spectrum of gas phase oscillations in the combustion chamber, this will cause oscillations in the heat input to the propellant surface which then couple with the decomposition mechanism to cause a change in the mean burning rate. The effect is what has been termed resonant or unstable burning of the

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propellant. Results which are obtained in the present paper permit calculation of this critical frequency as a function of the propellant parameters and the steady-state burning conditions. The analysis makes possible predictions of the relative effect of these parameters on the probability of encountering resonant burning, and these predictions appear at present to be in accord with experience.

867

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

LOW-PRESSURE DEFLAGRATION LIMITS IN THE STEADY DEFLAGRATION OF AMMONIUM PERCHLORATE PELLETS, by W. Nachbar. Sept. 1959 [21]p. incl. diagrs. tables. (Rept. no. LMSD-288168) (AFOSR-TN-59-1092) (AF 49(638)412) AD 234700
Unclassified

Recent experimental results on the deflagration of pure and catalyzed pellets of ammonium perchlorate are reviewed, and a proposed model to explain the observed low-pressure deflagration limit on the basis of radiative heat loss to the surroundings is discussed. Based upon calculations of representative estimates for the radiant energy emission from the combustion product gases of deflagration ammonium perchlorate, the radiative heat transfers from the product gases both to the surroundings and to the solid surface are calculated for several values of pressure. It is found that, in comparison with the effect of the radiative heat loss from the surface, the effect of radiative energy emission from the product gases upon the deflagration rate is probably small at the lowest pressure reported for steady deflagration. However, because product-gas radiation increases sharply in importance where the deflagration rate decreases rapidly with slowly decreasing pressure at the deflagration limit, its effects in a model for the deflagration limit cannot be neglected with certainty. (Contractor's abstract)

868

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

RADIANT ENERGY EMISSION FROM THE EQUILIBRATED REACTION PRODUCTS OF A PURE AMMONIUM PERCHLORATE PELLET, by D. Olfe and S. S. Penner. Sept. 1959 [49]p. incl. diagrs. tables. (Rept. no. LMSD-288169) (AFOSR-TN-59-1094) (AF 49(638)412) AD 235161
Unclassified

Representative estimates are made for the radiant energy emission from the combustion products formed by a burning pure ammonium perchlorate pellet. Because emission and absorption of radiation by the gases in the reaction zone are negligible, the compilations may be used to estimate radiant energy loss from the combustion products, as well as radiant heat transfer

to the burning propellant surface. The rectangular geometry chosen for the calculations is itself of no particular importance, and the results may be translated readily to other geometric configurations. (Contractor's abstract)

869

Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

ON THE ASSUMPTIONS UNDERLYING DROPLET VAPORIZATION AND COMBUSTION THEORIES, by F. A. Williams. Nov. 1959 [33]p. incl. diagrs. refs. (Rept. no. LMSD-288098) (AFOSR-TN-59-1148) (AF 49(638)412) AD 232688; PB 145845
Unclassified

Also published in Jour. Chem. Phys., v. 33: 133-144, July 1960.

A study is undertaken to determine the range of validity of the assumptions that (a) the liquid temperature is constant and equal to the boiling temperature for a burning droplet, (b) the instantaneous vaporization rate of a droplet at a given size is the same as that of a constant-diam sphere of the same size, and (c) the duration of the initial unsteady period is much less than the total vaporization time of a droplet. It is shown that assumption (a) may lead to observable differences between the theoretical and experimental burning rates for low-energy fuels, that for practical purposes assumption (b) is probably always valid, and that approximation (c), which is most accurate for large values of the temperature at infinity, may lead to a 20% error in the computed value of the total vaporization time. The calculated duration of the initial unsteady period compares favorably with experiments on droplet ignition delay times. (Contractor's abstract)

870

London U. Imperial Coll [of Science and Tech.] (Gt. Brit.).

[THERMODYNAMICS OF MOLTEN ALLOYS], by L.-L. Cheng. Final rept. Jan. 1, 1957-Dec. 31, 1958. Apr. 1959 [71]p. incl. diagrs. tables, refs. (Rept. no. 8) (AFOSR-TR-59-69) (AF 51(514)1179) AD 217816
Unclassified

Dilute solution of S in liquid Sn and Pb: By the use of radio-sulphur, the H_2S gas/liquid equilibrium reactions of Sn-S and Pb-S systems were measured at a low temperature, and a radiochemical method of analysis was developed for determining the S content in metal beads which were equilibrated with H_2S/H_2 mixture of known S potential. Based on 1 at.-% S in liquid Sn or Pb as the standard state, the free energy change for the reaction $[S]_{Sn} + 1/2 S_2$ was $\Delta G^\circ = 24,940 - 5.11 T \text{ cal}$ (500° to $680^\circ C$); $\Delta G^\circ = 23,140 - 4.59 T \text{ cal}$ for reaction $[S]_{Pb} + 1/2 S_2$. The thermodynamic behavior of S in liquid Sn and Pb

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at 600°C conformed with Henry's law below 0.44 and 0.38 at.-% S, respectively. Sn-Cu-S, Sn-Ag-S, Sn-Pb-S, and Cu-Ag-S systems: The effect of alloying elements on the activity coefficient of S in liquid metallic solution was studied. Ag additions to liquid Sn increased log D_S (distribution ratio) almost linearly up to about 40 at.-% Ag. At 66.5 at.-% Ag, the activity coefficient of S was increased to 40 times greater than it would be in pure liquid Sn. In the Sn-Cu-S system, Cu additions to liquid Sn decreased the activity coefficient of S instead of increasing it. The addition of Pb to liquid Sn did not decrease or increase the free electron/atom ratio. Three sets of measurements were made for Cu-Ag-S alloy studies at 1085°C. A small quantity of Cu-radio-sulphide was used as the S source to supply the equilibrium H_2S gas and the equilibrium S content of the condensed phases.

Lorentz Inst. Leyden (Netherlands).
see Leyden U. Lorentz Inst. (Netherlands).

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Louvain U. Lab. for Inorganic [and Analytical] Chemistry, Brussels (Belgium).

KINETICAL PARAMETERS IN PREMIXED LAMINAR FLAMES, by A. Van Tiggelen, R. Corbeels, and H. Vandenabeele. Feb. 1960, 43p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-59-1149) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium)) AD 234580; PB 146640
Unclassified

Activation energy and reaction order in CH_4 -O flames:

Experimental burning velocities, obtained at different fuel-to-O ratios, dilutions with N, and initial temperatures of the fresh gases, are almost perfectly represented by a formula where the classical kinetic parameters of a chemical reaction are present (activation energy (38 kcal) and reaction order with respect to O (1.4), and to CH_4 (-0.4)). The empirical formula corresponds exactly to the theory with a chain mechanism including the formation of a peroxide radical (CH_3O_2).

Reaction order in acetylene -O flames: The activation energy obtained was 31 kcal. The reaction order with respect to O varies between 2 and 0.8 and between -1 and 0.2 with respect to acetylene; the sum of both orders was always equal to unity and the negative value with respect to acetylene was valid at the rich side. A chain reaction with the formation of a peroxide must also occur in acetylene-O flames. Flame propagation velocity: CH_4 -H-O mixtures: Burning velocities and flame temperatures in stoichiometric ternary CH_4 -H-O mixtures at different dilutions with N were measured. These mixtures seem to correspond to a case of weak interaction between the 2 separate reactions. The ac-

tivation energy is about equal to the value given by a linear interpolation between the 2 extreme values (18 kcal for pure H and 38 for pure CH_4).

872

Louvain U. Lab. for Inorganic [and Analytical] Chemistry, Brussels (Belgium).

DETERMINATION OF ACTIVATION ENERGY AND REACTION ORDER IN PREMIXED LAMINAR FLAMES, by A. Van Tiggelen, P. J. Sloommaekers and others. Technical summary rept. Feb. 1959, 63p. incl. diagrs. tables, refs. (AFOSR-TR-59-36) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium)) AD 213039; PB 140778
Unclassified

Theoretical introduction: The theoretical basis, for the determination of the activation energy and of the reaction order with respect to fuel and oxidant from experimental data on burning velocities, is discussed. The theory is based on the branching condition in the flame front. Flame propagation in hydrazine mixtures: Measurements of flame propagation, temperature and flame front thickness in $N_2H_4/O_2/A$ are reported. These data are compared with literature data on N_2H_4 decomposition

flames. A general formula is given for the burning velocity in all kinds of N_2H_4 mixtures. Fluorine and chlorine flames: Flame propagation velocities are reported for fluorine mixtures with H_2 , CO and CH_4 .

Flame temperatures are calculated and used for the determination of activation energies in these flames. A comparison is made with H_2/Cl_2 flames. Comparative study of flame propagation in nitrocompound mixtures: The properties of flames in CH_3NO_2/O_2 , CH_3ONO/O_2 and $CH_4/NO_2/O_2$ mixtures in the presence of N_2 are compared. A different behavior is found between lean and rich mixtures. Influence on preheating on burning velocities: Some preliminary and fragmentary results are given concerning the influence of preheating on burning velocities.

873

Louvain U. Lab. for Inorganic [and Analytical] Chemistry, Brussels (Belgium).

COMPARATIVE STUDY OF FLAME PROPAGATION IN COMPOUNDS CONTAINING NITROGEN OXIDES, by S. De Jaegere and A. Van Tiggelen. [1959] [14]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium))
Unclassified

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Published in Combustion and Flame, v. 3: 187-200, June 1959.

Flame propagation velocities and temperatures have been measured in methyl nitrite, nitromethane and methane-nitrogen dioxide mixtures with oxygen. Mixtures of methyl nitrite or methane plus nitrogen dioxide with sufficient oxygen behave like more classical fuel-oxidant mixtures. Activation energies and reaction orders with respect to fuel and oxidant have been derived. Very rich methyl nitrite-oxygen flames are to be compared with pure methyl nitrite decomposition flames: their burning velocities are abnormally low. Nitromethane-oxygen flames are characterized by a low activation, but are much slower than what might be expected from the theory.

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Louvain U. Lab. for Inorganic and Analytical Chemistry, Brussels (Belgium).

FLAME PROPAGATION VELOCITY METHANE-HYDROGEN-OXYGEN MIXTURES, by R. Corbeels and A. Van Tiggelen. [1959] [7]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium)) Unclassified

Published in Bull. Soc. Chim. Belg., v. 68: 613-619, Nov.-Dec. 1959.

Flame propagation velocities and temperature in composite stoichiometric mixtures $H_2/CH_4/O_2$ at different compositions and dilution have been investigated. The experimental results show a weak interaction in the sense of a weak inhibition of hydrogen combustion by methane and a weak promotion of the methane combustion by hydrogen. The activation energy of the branching process in these composite mixtures lies between the values derived from experiments on the separate binary mixtures H_2/O_2 and CH_4/O_2 . (Contractor's abstract)

875

Louvain U. [Lab. for Inorganic and Analytical Chemistry] Brussels (Belgium).

ACTIVATION ENERGY AND REACTION ORDER IN METHANE-OXYGEN FLAMES, by H. Vandenberghe, R. Corbeels, and A. Van Tiggelen. [1960] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1245 and Fonds National de la Recherche Scientifique (Belgium)) Unclassified

Published in Combustion and Flame, v. 4: 253-260, Sept. 1960.

Flame propagation velocities and temperatures have

been measured in preheated and unpreheated methane-oxygen mixtures at different mixture strengths and varying dilutions with nitrogen. An activation energy of 38 kcal can be derived from these measurements. The order of the reaction with respect to oxygen is 1.4 and with respect to methane, -0.4. These parameters (orders and activation energy) are ascribed to the branching process. The reaction mechanism is discussed.

876

Louvain U. Lab. of Biophysics, Brussels (Belgium).

THE EXPERIMENTAL APPROACH TO PAIN, by A. E. McKenna. May 15, 1958 [37]p. incl. diagr. tables, refs. (Technical note no. 1) (AFOSR-TN-59-122) (AF 61(514)1101) AD 210427 Unclassified

Also published in Jour. Appl. Physiol., v. 13: 449-456, Nov. 1958.

A modification of the Hardy-Wolff-Goodell method of stimulation by thermal radiation was used in an experimental approach to pain. Thresholds of pain sensation were obtained in the usual manner, but response was measured, not only by the judgment of subjects, but by the reactions in a group of physiological variables as well; these included EEG, EKG, PGR and change in respiration. The threshold values obtained in terms of skin temperatures at stimulus site after irradiation were considerably higher (47.3-48.6°C) than those reported in previous investigations. Differences in threshold skin temperatures at different exposure times imply that the determinant for the sensation is not a critical temperature at skin surface, but is either a critical temperature at receptor level or a temperature difference between receptor level and deeper fibers. Questioning of the subjects revealed that the particular sensation experienced at the pain threshold was not painful for the large majority. Consequently, results obtained in threshold investigation can have no applicability to the human pain problem in real life. (Contractor's abstract)

877

Louvain U. Lab. of Biophysics, Brussels (Belgium).

PSYCHOGALVANIC RESPONSE AS A PAIN REACTION COMPONENT, by A. E. McKenna. [1959] [6]p. incl. diagrs. (AFOSR-TN-59-469) [AF 61(514)1101] AD 244808 Unclassified

Also published in Jour. Appl. Physiol., v. 14: 881-886, Nov. 1959.

Psychogalvanic responses (PGR) were measured in human subjects as responses to cutaneous stimulation by thermal radiation. There were 37 subjects of both sexes, aged 18-40 yr, and there were 2054 presentations. An apparatus for recording PGR on an EEG tracing is described. Based on physical intensity of stimulus

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there is a complete overlap of pain-nonpain categories - from 35° to 55°C end temperature in irradiated skin. Plotting magnitude of PGR against physical intensity of stimulus for pain and nonpain categories reveals that the intensity of reaction in pain is not determined by physical intensity of stimulus. When the magnitude of reaction is compared as between pain and nonpain responses on the basis of the same stimulus intensities, it is found to be greater for pain to a highly significant extent; on the same basis, duration of response is longer for pain, but not at a high level of significance. The PGR is shown to be an accurate discriminator of the subjective pain sensation threshold. When electrocortical reactions are compared to electrodermal reactions, both are found to be triggered in a consistent manner by the common stimulus, the consistency being reduced when the subject judges the stimulus painful. The effects of habituation are examined and shown not to be causal to results. Implications of the findings for the pain experience in the true life situation are discussed. (Contractor's abstract)

878

Louvain U. [Lab. of Chemical Physics] Brussels (Belgium).

STUDIES ON THE MECHANISM OF ELECTROLUMINESCENCE, by A. Luyckx, J. Vandewauwer and others. Final technical rept. Nov. 15, 1956-Nov. 14, 1958, 58p. incl. diagrs. tables. (AFOSR-TR-59-12) (AF 61(514)-1118) AD 210472; PB 139585 Unclassified

Electroluminescence of single crystals at variable frequency was studied. Zinc sulfide powder was activated by Cu, Cl, or Cu, Cl and Pb to form electroluminescent ZnS powders. The crystals were grown by sublimation of electroluminescent ZnS powder at a temperature between 1150° and 1220°C in an atmosphere containing a mixture of H₂S and H (50% of each) at a

pressure of 15 cm Hg measured at room temperature. Recrystallization occurs in a colder region of the quartz tube used as distillation apparatus. These crystals had to be activated by heating the crystal in an electroluminescent ZnS powder in which a drag of deliquescent ZnCl₂ was mixed. Distinctions were made between

ohmic and capacitive crystals at variable frequency. The 2 types of crystals behave differently in regard to light output, impedance and oscillograms of current and fields. These features were studied separately for each type of crystal. For all capacitive crystals, at each voltage, light output remained unvariable above a certain frequency, although current increased with frequency. For ohmic crystals, light increases with frequency. The evolution of crystals from ohmic type to capacitive type occurred when a dc field was imposed during a certain time.

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Lund U. Dept. of Pharmacology (Sweden).

THE 'DESENSITIZING' EFFECT OF ACETYLCHOLINE ON THE MAMMALIAN MOTOR END-PLATE, by J. Axelsson and S. Thesleff. [1959] [12]p. incl. diagrs. tables. (Technical scientific note no. 1) (AFOSR-TN-59-299) (AF 61(052)103) AD 213083 Unclassified

Also published in Acta Physiol. Scand., v. 43: 15-26, 1958.

A micro-application technique was used to study the receptor desensitization which acetylcholine produces at the mammalian motor end-plate. In all the investigated muscles a steady release of acetylcholine produced a loss of sensitivity in the end-plate membrane. The results suggest that the concentrations of acetylcholine which produce desensitization are in certain mammalian muscles within the range of concentrations normally produced at the end-plate by a motor-nerve impulse and that consequently desensitization may develop during repetitive motor nerve stimulation. (Contractor's abstract)

880

Lund U. Dept. of Pharmacology (Sweden).

A STUDY OF THE INTERACTION BETWEEN NEUROMUSCULAR BLOCKING AGENTS AND ACETYLCHOLINE AT THE MAMMALIAN MOTOR END-PLATE, by S. Thesleff. [1959] [11]p. incl. diagrs. refs. (Technical scientific note no. 2) (AFOSR-TN-59-300) (AF 61(052)106) AD 213084 Unclassified

Also published in Acta Anaesth. Scand., v. 2: 69-79, 1958.

Ionophoretic micro-application of drugs and intracellular electrodes were used to study the effects of neuromuscular blocking drugs on the motor end-plate of single mammalian muscle fibers. The results obtained with d-tubocurarine and gallamine are compatible with the belief that these drugs block neuromuscular transmission by competing with acetylcholine for end-plate receptors. Decamethonium and succinylcholine on the other hand produce a neuromuscular block by end-plate depolarization as well as by non-competitive receptor desensitization. (Contractor's abstract)

881

Lund U. Dept. of Pharmacology (Sweden).

A STUDY OF SUPERSENSITIVITY IN DENNERVATED MAMMALIAN SKELETAL MUSCLE, by S. Thesleff and J. Axelsson. Sept. 15, 1959 [13]p. incl. diagrs. refs. (Technical scientific note no. 3) (AFOSR-TN-59-1189) (AF 61(052)106) AD 234149 Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in Jour. Physiol., v. 147: 178-193, June 23, 1959.

The sensitivity to acetylcholine of chronically denervated mammalian skeletal muscle was studied by ionophoretic micro-application of the agent to single muscle fibers. In an innervated muscle acetylcholine produces membrane depolarization only when applied to the small and limited end-plate region of a fiber. In a denervated muscle, however, the entire muscle membrane becomes sensitive to acetylcholine. One to two wk after denervation the whole surface of the muscle is about as sensitive to acetylcholine as the end-plate region which has maintained its original responsiveness to the drug. The muscle is uniformly sensitive to acetylcholine which wherever applied to the membrane produces a depolarization of a similar magnitude and time course as when applied to the end-plate region of an innervated muscle. It is concluded that the increase in the size of the receptor area, following denervation, accounts for the hypersensitivity of denervated muscles to acetylcholine and also explain the contracture produced in denervated mammalian muscles of depolarizing drugs. (Contractor's abstract)

882

Lund U. Dept. of Pharmacology (Sweden).

BRAIN CATECHOL AMINE CONTENT AFTER SECTIONING THE ADRENERGIC NERVES TO THE BRAIN VESSELS, by A. Bertler and E. Rosengren. [1959] [3]p. incl. table. (AFOSR-609) (AF 61(052)106) AD 255286 Unclassified

Also published in Acta Physiol. Scand., v. 47: 362-364, 1959.

The catechol amine content of rat brains after extirpation of the superior cervical ganglia was investigated, and the values compared to those obtained from a sham-operated group of animals. There was no difference between the 2 groups, suggesting that sympatho-adrenergic nerves do not significantly contribute to the brain catechol amine content in rats. (Contractor's abstract)

883

Lund U. Thermochemistry Lab. (Sweden).

EXPLORATORY STUDIES ON THE PHOTOLYSIS OF DISULFIDES IN AN ORGANIC MATRIX AT 77°K, by K. Rosengren, S. Sunner, and D. Timm. Aug. 1, 1959 [14]p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-59-572) (AF 61(052)16) AD 230183; PB 145677 Unclassified

In an exploratory investigation aiming at the determination of "bond formation" energies by measuring the heat effect accompanying the recombination of radicals trapped in an organic matrix at 77°K, the photolysis of disulfides has been studied. It was found that disul-

fides were easily photolyzed, that the disappearance of the disulfide could be quantitatively followed by UV spectrophotometry, that during photolysis a new, unstable absorption band appeared at 232 mμ which preliminarily was assigned to the thiyl radical, that the primary reaction product did react with the hydrocarbons used for the formation of matrices and that the matrices investigated at 77°K are too close to (or already within) the premelting region. (Contractor's abstract)

884

Lund U. Thermochemistry Lab. (Sweden).

EQUILIBRIUM STUDIES ON THE DISPROPORTIONATION REACTION BETWEEN SOME DIALKYL DISULFIDES, by L. Haraldsson, C. J. Olander and others. May 1, 1960, 8p. incl. tables. (Technical note no. 3) (AFOSR-TN-59-573) (AF 61(052)46) AD 244327; PB 152478 Unclassified

The disproportionation equilibrium between 2 symmetric disulfides and the corresponding mixed 1 has been determined at 25° and at 60° by use of vapor phase chromatographic technique. For diethyl disulfide in mixture with dimethyl- and di-iso-propyl disulfide, respectively, the equilibrium constant is close to the statistically expected value, 4. For the pair diethyl- and di-tert-butyl disulfide, the constant is 24. Within the uncertainty of the experiments, the equilibrium constant is temperature independent and thus ΔH is equal to zero. The strongly restricted internal rotation in di-tert-butyl disulfide is responsible for the high value of the equilibrium constant. (Contractor's abstract)

885

Lund U. Thermochemistry Lab. (Sweden).

EQUILIBRIUM STUDIES ON DISULFIDES PHASE CHROMATOGRAPHY, by C. J. Olander and S. Sunner. June 1, 1958, 5p. incl. table. (Technical note no. 1) (AFOSR-TN-59-731) (AF 61(052)46) AD 219421; PB 145610 Unclassified

Some general aspects are given on the use of vapor phase chromatographic technique for the determination of equilibrium constants. The usefulness has been demonstrated for the disproportionation reaction between dimethyl and diethyl disulfide. (Contractor's abstract)

Lyman Lab. of Physics, Cambridge, Mass.

See Harvard U. Lyman Lab. of Physics, Cambridge, Mass.

886

Lyons U. Dept. of Physiology (France).

SUBCORTICAL PHOTICALLY AND SOMESTHETICALLY

AIR FORCE SCIENTIFIC RESEARCH

EVOKED ELECTRIC ACTIVITY IN THE HUMAN
BRAIN DURING ATTENTION, by M. Jouvett and H.
Hermann. [1959] 10p. (AFOSR-TN-59-697) (AF 61-
(514)1206) AD 219392 Unclassified

Presented at Thirtieth annual meeting of the Aero Med.
Assoc., Los Angeles, Calif., Apr. 27-29, 1959.

Abstract published in Aerospace Med., v. 30: 190, Mar.
1959.

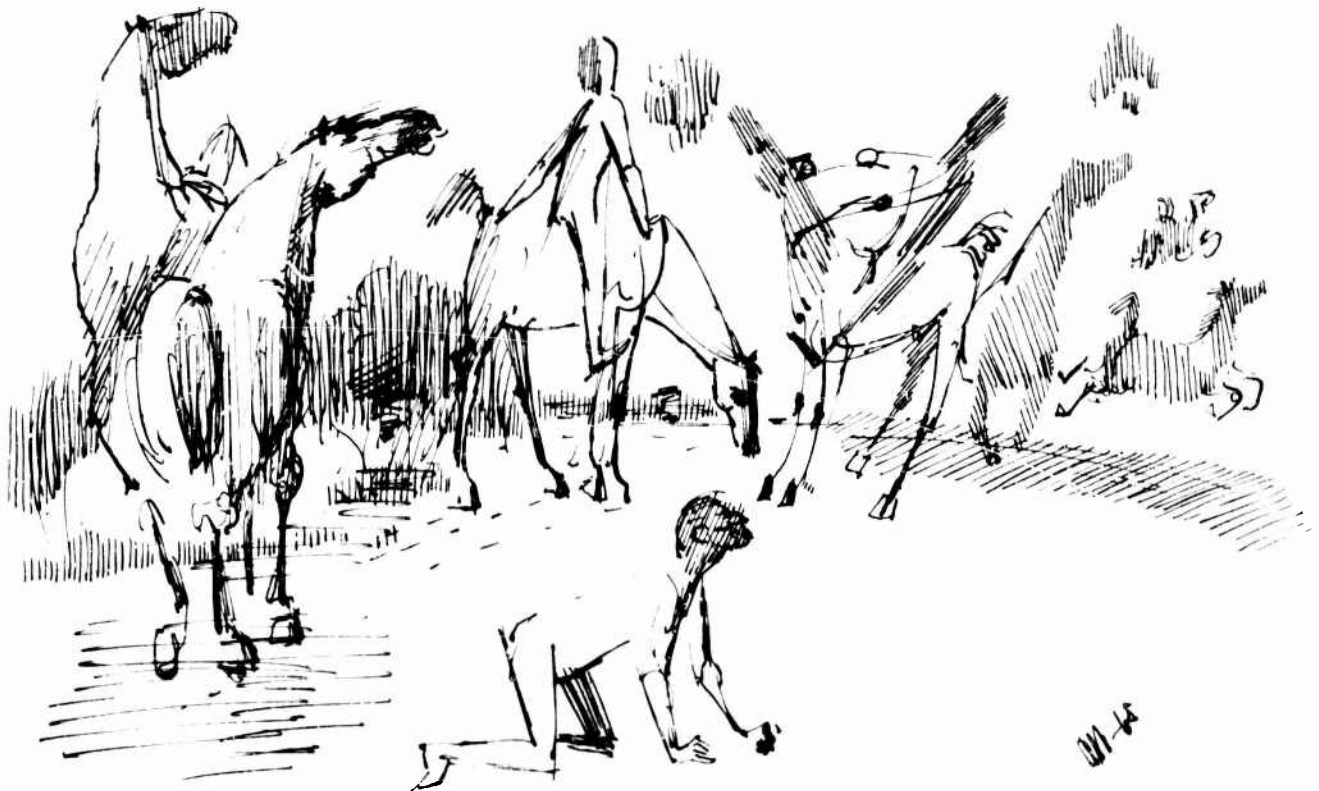
Stereotaxically oriented recording electrodes have been introduced at the subcortical level of the visual system or at the thalamic level of the somesthetic system in conscious human subjects. Evoked responses to photic stimuli or tactile stimuli are enhanced when the patient pays attention to them. These responses diminish greatly when the patient pays attention to another modality of stimuli. In patients with disturbances of consciousness (confused or comatous state) responses do not show any variation. These results are in agreement with experiments on animals. It may be concluded that some facilitatory mechanism acts during attention in order to enhance afferent significant responses to the cortex and block other nonsignificant stimuli. Cortex and reticular formation of the brain stem may play a foremost role in this system. (Contractor's abstract)

887

Lyons U. Dept. of Physiology (France).

NEUROPHYSIOLOGICAL MECHANISMS OF LEARNING,
by M. Jouvett. Final technical rept. Jan. 1, 1957-Dec.
31, 1958. June 1959, 35p. incl. diagrs. refs. (AF 61-
(514)1206) AD 218359; PB 142308 Unclassified

Results obtained from experiments on 50 chronic cats show that habituation of the arousal reaction cannot be explained by a functional deafferentation of the activating reticular system. The main problem to investigate was the process of falling asleep. Investigations were directed to calculate what inhibitory mechanisms would act upon the activating ascending system. It was found that during physiological sleep, slow waves are recorded from cortex, diencephalon, and mesencephalon, in normal cats, subtotally decorticated cats, or cats with sub-total section of the brain stem. However, there was no slow wave evidence during sleep in the diencephalon or the mesencephalon of totally decorticated cats and no slow waves in the mesencephalon in mesencephalic cats. These results show that a diffuse inhibitory system in which the cortex plays a foremost role acts upon the reticular formation during physiological sleep in normal cats.



AIR FORCE SCIENTIFIC RESEARCH

888

McMaster U. Hamilton Coll., Ont. (Canada).

SOME NEW ATOMIC MASS DETERMINATIONS MADE WITH A LARGE SINGLE-FOCUSING MASS SPECTROMETER, by J. T. Kerr, G. R. Bainbridge and others. Jan. 1, 1959, 9p. incl. diagrs. tables, refs. (AFOSR-TN-59-618) (AF 49(638)247) AD 238215
Unclassified

Also published in Proc. Conf. on Advances in Mass Spectrometry, London U. (Gt. Brit.) (Sept. 24-26, 1958), New York, Pergamon Press, 1959, p. 1-9.

A large semi-circular magnetic analyzer with a resolving power (at the base of the peaks) of ~9000 has been used to determine the atomic masses of Kr^{84} , Kr^{86} , Xe^{129} , Xe^{132} , Hg^{200} , Hg^{201} and Hg^{204} to a precision of ~1/2,000,000. In this work the necessary doublet spacings were determined by a beam modulation technique. This technique and certain other details of the apparatus are described.

889

Madrid U. Dept. of Crystallography (Spain).

STUDIES OF THERMAL MOTION IN CRYSTALS, by J. L. Amorós. Final technical rept. Dec. 15, 1956-Dec. 14, 1958, 70p. incl. illus. diagrs. refs. (AFOSR-TR-59-47) (AF 61(514)1146) AD 215061
Unclassified

A systematic survey of thermal continuous diffuse scattering has been done in chain crystals and a scheme of the dynamics of such molecular crystals have been advanced. The atomic vibrations in such crystals have been studied by a direct way, and some relations between thermal expansion, polymorphism and thermal diffuse scattering have been studied in crystals such as oxalic acid dihydrate and α -succinic acid. The interpretation of x-ray thermal (continuous) diffuse scattering has been accomplished in terms of a new function: the "difference Fourier transform" (DFT) of the molecules and a full record of such thermal diffuse scattering has been obtained for hexamine, naphthalene and anthracene. DFT gives good agreement with experiment showing that the main contribution to continuous diffuse scattering is that of the independent movement of the molecules in the crystal. (Contractor's abstract)

890

[Madrid U. Instituto de Calculo (Spain)]

SEMI-ANALYTICAL FUNCTIONS IN CONVEX REGIONS, by R. San Juan Llosá. [1959] 357p. incl. refs. (AFOSR-TR-59-60) [AF 61(514)1254] AD 216625; PB 145097
Unclassified

A study is presented of the relations between convex plan sets and convex curves, i.e., the graphics of convex continuous functions. The convex functions are always upper bounded in every finite interval, which becomes equivalent to its continuity. Unbounded convex sets, which are not as widely studied as bounded sets, are mainly considered. The conclusions are established for convex functions, but they are also valid for concave functions. (Contractor's abstract)

Mallinckrodt Chemical Lab., Cambridge, Mass.
see Harvard U. Mallinckrodt Chemical Lab., Cambridge, Mass.

891

[Marey Inst., Paris (France).]

[DUALITY OF RESPONSES OF CELLS OF THE MEDIAN CENTER OF THE THALAMUS TO NATURAL OR ELECTRICAL STIMULI] Dualité des réponses des cellules du centre médian du thalamus à des stimulations naturelles ou électriques, by D. Albe-Fessard and M. L. Kruger. [1959] [3]p. incl. illus. (AFOSR-TN-59-541) (AF 61(052)103)
Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 248: 299-301, Jan. 12, 1959.

Electrical stimuli or natural stimuli in the form of abrupt pressure by means of a percussion instrument or needle-point applied on the cornea, periosteum, skin, and joint sheaths in almost all parts of the body of the cat evoked responses of the cells of the median center of the thalamus. 186 units in 8 cats were examined; 15 of them were active. 55 units showed responses of short latency (19.5 and 24.3 msec for anterior and posterior limbs, respectively), corresponding to a conduction rate of 50 msec. The responses of 58 other units showed long latency (av 625 msec), corresponding to a rate of 10 msec. It is concluded that the fact of slow conduction may correspond to some form of pain sensitivity connected with spino-thalamic pathways.

892

[Marey Inst., Paris (France).]

[STUDY OF VISUAL AND AUDITORY "ASSOCIATION" SYSTEMS IN THE CAT UNDER CHLORALOSE ANESTHESIA] Etude des Systèmes "Associatifs" Visuel et Auditifs chez le Chat Anesthésié au Chloralose, by P. Buser, P. Borenstein, and J. Bruner. [1959] [20]p. incl. illus. diagrs. table, refs. (AFOSR-TN-59-786) (AF 61-(052)103) AD 227805
Unclassified

Published in Electroencephalog. and Clin. Neurophysiol., v. 11: 305-324, 1959.

In cats deeply anesthetized with chloralose, cortical

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responses to visual or auditory stimulations can be observed in the suprasylvian and lateral anterior gyri. These cortical "association" responses as well as the subcortical pathways upon which they depend were the object of this study. The significance of the results obtained, especially the fact that experimentation under deep chloralose anesthesia permits specific association systems to be identified, is discussed.

893

[Marey Inst., Paris (France)]

[DIFFERENTIAL CHARACTERISTICS OF RESPONSES TO SENSORY STIMULATION OF PARTS OF THE RED NUCLEUS] Caractéristiques différentielles des réponses aux stimulations sensorielles des deux parties du noyau rouge, by J. Massion and D. Albe-Fessard. [1959] [3]p. incl. illus. (AFOSR-TN-59-1010) [AF 61(052)103] Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 248: 3747-3749, June 29, 1959.

The area of the red nucleus of the anesthetized cat is shown to respond to various stimulations. With the aid of microelectrodes, the red nucleus was studied systematically and 3 modes of response were noted: (1) a short response with short latency, (2) the same response followed by an unexpected influx, (3) a short response sometimes repeated and followed then after a longer period by a rapid influx. These types of responding cells were located and their percentage tabulated.

894

[Marey Inst., Paris (France)]

[ROLE OF CEREBELLAR RELAYS IN THE ACTIVATION OF THE PACEMAKER OF LARGE NEURONS OF THE RED NUCLEUS] Role de relais du cervelet dans l'activation d'origine sensitive des neurones magnocellulaires du noyau rouge, by D. Albe-Fessard and J. Massion. [1959] [3]p. incl. illus. (AFOSR-TN-59-1011) [AF 61(052)103] Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 249: 315-317, July 15, 1959.

The 3 responses noted in the red nucleus are examined and several hypothesis are put forth to account for them. The one which is particularly treated here states that the influx afferents connect with the cells of the posterior red nucleus by indirect as well as direct pathways. This allows a relay to be established from other parts of the cerebral structures. Experiments are described on partial and complete decerebration and decerebellation. This helps establish the pathway involved. The inhibition mechanism is also discussed.

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[Marey Inst., Paris (France)]

[DUALITY OF OBSERVED RESPONSES IN THE CENTRAL MEDIAN AT THE TIME OF SOMATIC STIMULATIONS. TYPES OF AFFERENCES AND SPINAL TRACTS] Dualité des réponses observées dans le centre médian lors de stimulations somatiques. Types d'afférences et voies spinales, by [M.] L. Kruger and D. Albe-Fessard. [1959] [1]p. (AFOSR-TN-59-1012) [AF 61(052)103] Unclassified

Also published in Jour. Physiol. (Paris), v. 51: 501-502, June 1959.

The thalamic regions were examined from a histological point of view. The structures are identified where response corresponds to morphological regions, such as the reticular nucleus and the central and parafascicular nuclei. The last 2 are reported on here. The cells in these areas respond to both artificial stimulation (pressure) and natural stimulation (electrodes). There are reportedly 3 types of responses: (1) those which respond with a short latency only, (2) those which respond with a long latency, (3) those which respond with a short and then long latency.

896

[Marey Inst., Paris (France)]

[MACRO- AND MICRO-PHYSIOLOGICAL STUDY ON THE EVOKED RESPONSES OF THE RED NUCLEUS CAUSED BY SENSORY STIMULATION] Etude macro- et micro-physiologique des réponses évoquées dans le noyau rouge par des stimulations sensitivo-sensorielles, by D. Albe-Fessard and J. Massion. [1959] [2]p. (AFOSR-TN-59-1013) [AF 61(052)103] Unclassified

Also published in Jour. Physiol. (Paris), v. 51: 385, June 1959.

The inhibition mechanism of the responses found in the cells of the red nucleus is discussed. By ablation and stimulation the area of inhibition is sought along with its pathway. Two distinct paths are found to have access to the red nucleus.

897

[Marey Inst., Paris (France)]

[POSSIBILITY OF A TRANSFER OF POST-TETANIC FACILITATION IN A DISYNAPTIC CHAIN] Possibilité d'un transfert de la facilitation post-tétanique dans une chaîne disynaptique, by [D.] Albe-Fessard and T. Szabo. [1959] [2]p. (AFOSR-TN-59-1135) [AF 61(052)103] Unclassified

Also published in Jour. Physiol. (Paris), v. 51: 465-466, June 1959.

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The conditions for transfer of the post-tetanic facilitation which occurs in monosynaptic transmission caused by a repetitive stimulus of sufficient frequency are discussed. It is thought that the post-tetanic potentiation (P.T.P.) must play a vital role in the phenomenon. It had been established that 2 neurons, A and B, converging on a common neuron, C, was essential for occurrence. This allows for auto-activation to occur. It is thought that neuron C receives the potentiation from both B and A neurons which are capable of recruiting the larger D neurons. This results in prolonging the effect on C. This fits well with the disinaptic structure which is already known. Electrode investigations show that the amplitude of the action potential is important for recruitment. It is also shown that various explanations can be reached by application of this principle to other parts of the central nervous system.

898

Maryland U. Dept. of Physics, College Park.

GEOPHYSICAL EFFECTS OF SOLAR CORPUSCULAR RADIATION, by S. F. Singer. [1959] [5]p. incl. refs. (AFOSR-TN-59-163) (AF 18(600)1038) AD 211142
Unclassified

Also published in Ann. Geophys., v. 14: 433-437, Oct.-Dec. 1958.

Magnetic storms, aurorae and cosmic ray variations are explained from a unified theoretical point of view. The sudden commencement of magnetic storms seems to be due to ionospheric currents initiated by solar corpuscular radiation. The main phase of storms is explained in terms of an extra terrestrial ring current set up by the drifting motion of trapped solar particles. These trapped particles are also accelerated to high enough energies to cause aurora; the acceleration proceeds mainly by Fermi collisions with magnetohydrodynamic waves (which give rise to geomagnetic micropulsations). Decreases in cosmic ray intensity which accompany magnetic storms are produced by a diffusive deceleration process in interplanetary space. (Contractor's abstract)

899

Maryland U. Dept. of Physics, College Park.

SUMMARY OF RESULTS OF RESEARCH STUDY. [1959] [18]p. incl. refs. (AFOSR-TN-59-168) (AF 18(600)1038) AD 211147; PB 139992
Unclassified

During the performance of this contract, a great deal of theoretical work was done on various aspects of cosmic rays and auroral particles. A number of papers are cited which came out under this contract relating to scientific problems of earth satellites. A major review article on research in interplanetary physics was written by the project director and is summarized in an appendix which is included. Regarding

the experimental work done under this contract, the objectives, the design of the experimentation, the design of the apparatus used, and the results are all outlined.

900

Maryland U. Dept. of Physics, College Park.

ROLE OF RINGCURRENT IN MAGNETIC STORMS (Abstract), by S. F. Singer. [1958] [1]p. (AFOSR-TN-59-239) [AF 18(600)1038]
Unclassified

Also published in Trans. Amer. Geophys. Union, v. 39: 532, June 1958.

E. N. Parker has thrown doubt on the existence of this ringcurrent. He concludes: (1) Even if it exists, the effects of the ringcurrent cannot be felt on Earth and therefore cannot give rise to magnetic storms because of the high conductivity of the Earth's outer atmosphere. (2) The main phase of magnetic storms can be explained in terms of an ionospheric current system. In the present analysis of the problem of the origin of magnetic storms conclusions were reached which are directly opposite to those of Parker's. The main difference seems to be that the effect of a magnetic field on the anisotropic conductivity is considered, a physical mechanism (trapped protons drifting in the Earth's field) which produces an equatorial ringcurrent at a distance of five to ten Earth-radii was investigated. (Contractor's abstract)

901

Maryland U. [Dept. of Physics] College Park.

TRAPPED ORBITS IN THE EARTH'S DIPOLE FIELD (Abstract), by S. F. Singer. [1959] [2]p. (AFOSR-TN-59-240) [AF 18(600)1038]
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 26-28, 1956.

Also published in Bull. Amer. Phys. Soc., Series II, v. 1: 229, Apr. 26, 1956.

See item no. MDU.03:016, Vol. I for abstract.

902

Maryland U. Dept. of Physics, College Park.

SOME CONSEQUENCES OF A THEORY OF THE RADIATION BELT, by S. F. Singer. [1958] [7]p. incl. diagrs. (AFOSR-TN-59-241) [AF 18(600)1038] AD 212104
Unclassified

Presented at Ninth Internat'l. Astronaut. Cong., Amsterdam (Netherlands), Aug. 25-30, 1958.

AIR FORCE SCIENTIFIC RESEARCH

Also published in Jour. Brit. Interplanetary Soc., v. 16: 558-564, Nov.-Dec. 1958.

A theory has been developed (MDU.03:042, Vol. II) to account for the "radiation belt" reported by Explorer and Sputnik satellites. This theory gives the origin of the radiation, its nature and energy, and its distribution around the Earth with latitude and with altitude. This note summarizes the results of the theory and investigates its consequences for studies of the outer atmosphere of the Earth, the planets and Moon; particular attention is paid to space medical implications and means of protection against the radiation. The most promising counter-measure appears to be "sweeping-out" of the radiation. Finally, more novel experiments to test the trapping properties of the Earth's magnetic field are suggested. (Contractor's abstract)

903

Maryland U. Dept. of Physics, College Park.

SCIENTIFIC PROBLEMS IN CISLUNAR SPACE AND THEIR EXPLORATION WITH ROCKET VEHICLES, by S. F. Singer. [1958] [10]p. incl. diagrs. refs. [AF 18(600)1038] Unclassified

Published in Proc. Ninth Internat'l. Astronaut. Congress, Amsterdam (Netherlands) (Aug. 25-30, 1958), Vienna, Springer-Verlag, v. 2: 904-913, 1959.

Also published in Astronaut. Acta, v. 5: 116-125, 1959.

The paper discusses scientific measurements which can be carried out in the "cislunar" region between the earth and the moon. Stress is placed on such problems as the space distribution and intensity of cosmic rays, auroral particles, and other corpuscular radiations some of which might be responsible for the magnetic storm producing ring current. The moon's magnetic field is discussed, as well as measurements of the lunar atmosphere and lunar tidal bulge.

904

Maryland U. Dept. of Physics, College Park.

ELECTRON SPIN RESONANCE OF ULTRAVIOLET IRRADIATED COMPOUNDS. I. UNSATURATED HYDROCARBONS, by C. P. Poole, Jr. and R. S. Anderson. [1959] [29]p. incl. diagrs. tables, refs. (Technical rept. no. 120) (AFOSR-TN-59-407) (Also bound with its AFOSR-217; AD 251449) (AF 18(600)1582) AD 214504; PB 140505 Unclassified

Also published in Jour. Chem. Phys., v. 31: 346-354, Aug. 1959.

Trapped radicals, formed by ultraviolet irradiation of pure, unsaturated aliphatic hydrocarbons, maintained at 77°K, have been observed with a 3-cm electron spin resonance spectrometer at g-factor of 2. Straight chain

radicals were characterized by well resolved hyperfine structure of 4 or more components. Only those hydrogen atoms attached to carbon atoms at or adjacent to the location of the unpaired electron are found to contribute appreciably to the observed hyperfine structure. Their hyperfine coupling constants are approximately equal. Radical formation and stabilization is attributed to the separation from the parent molecule of highly mobile hydrogen and methyl radicals which diffuse away from the remaining radical fragments, and eventually react with their environment or recombine. Stabilization of remaining fragments then occurs because of immobility and structural resonance. The number of radical spins detected was of the order 10^{16} to 10^{18} in 1 ml samples. Most radicals were stable for weeks at 77°K. Consideration is given to the existence of radicals resulting from secondary hydrogen addition reactions. (Contractor's abstract)

905

Maryland U. Dept. of Physics, College Park.

RADICALS TRAPPED IN VISCOUS MEDIA (Abstract), by K. Hotta and R. S. Anderson. [1959] [1]p. (Bound with its AFOSR-217; AD 251449) (AF 18(600)1582) Unclassified

Presented at Fourth Internat'l. Symposium on Free Radical Stabilization. Washington, D. C., Sept. 1, 1959.

Electron spin resonance techniques were used to identify radicals existing during non-steady state polymerization reactions of methyl methacrylate, styrene, a-methyl styrene, and vinyl acetate. In most cases the radicals observed were created by the action of initiator radicals induced by ultraviolet irradiation. Observation at 77°K of benzoyl peroxide initiates monomer radicals in the initial stage of polymerization of methyl methacrylate and a-methyl styrene shows that the action of the initiator is principally hydrogen abstraction from the monomer. In styrene, where abstraction is energetically unfavorable, initiator addition occurs. Examination of a 1:1 styrene-methyl methacrylate comonomer shows that radicals from both monomers initially exist in about equal proportions. With methyl methacrylate the same radical appears at all stages of the polymerization reaction, except during photodegradation, when an additional radical is present. Viscosity measurements demonstrated that detectable quantities of radical ($10^{15}/\text{cm}^3$) created at room temperatures do not exist until the polymer molecular weight exceeds 10^5 . In general about 10^{17} radicals/cm³ were observed, corresponding to 1 radical per 100 molecules.

AIR FORCE SCIENTIFIC RESEARCH

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Maryland U. Dept. of Physics, College Park.

THE V-A FOUR-FERMION INTERACTION AND THE INTERMEDIATE CHARGED VECTOR MESON, by S. Oneda and J. Pati. Dec. 1958, 11p. incl. diagrs. refs. (Technical rept. no. 126) (AFOSR-TN-59-46) (AF 49-636)24 AD 209417 Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 125-127, Feb. 1, 1959.

The consequences of this hypothesis are given for the spectrum in K_{e3} , K_{u3} and muon decay, and for the muon lifetime.

907

Maryland U. Dept. of Physics, College Park.

INTEGRAL EQUATION FOR PRODUCTION PROCESSES, by J. Sucher and T. B. Day. Jan. 1959 [14]p. incl. diagrs. (Technical rept. no. 130) (AFOSR-TN-59-153) (AF 49(638)24) AD 211113; PB 142539 Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 1111-1116, 1959. (Title varies)

An integral equation is derived which exhibits directly the relation between an amplitude for production, including all interactions, and the corresponding amplitude for complete scattering between the initial particles alone, and between the final particles alone. The only non-measurable quantity involved in this relatively simple relation is shown to be an amplitude for "pure production" in which intermediate states with either the initial particles or the final particles are excluded. (Contractor's abstract)

908

Maryland U. Dept. of Physics, College Park.

K^- , \bar{K}^0 RELATIVE PARITY FROM THE K^- -D CHARGE EXCHANGE REACTION, by T. B. Day, G. A. Snow, and J. Sucher. Apr. 1959 [26]p. incl. diagrs. table, refs. (Technical rept. no. 132) (AFOSR-TN-59-435) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 214787 Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 614-627, Aug. 1, 1959.

The reaction $K^- + D \rightarrow \bar{K}^0 + 2n$ is studied in the hope that limitations on the final states for the 2 neutrons due to statistics will help differentiate between even and odd relative parity of the K^- and \bar{K}^0 mesons. The total cross-section for the reaction is calculated in the impulse approximation, and expressed in terms of the

corresponding hydrogen cross-section for both even and odd parity. The calculations are carried out (a) with the use of antisymmetrized plane waves for the 2 neutrons, and (b) in the closure approximation. The ratio of the odd to even parity cross-sections is about a factor of 2 in either approximation. The total cross-section for odd parity in the plane wave approximation is found to be about 4 mb at a K^- laboratory momentum of 136 mev/c. (Contractor's abstract)

909

Maryland U. Dept. of Physics, College Park.

Λ^0 AND Σ^0 PRODUCTION FROM THE (Σ^- , D) SYSTEM, by T. B. Day, G. A. Snow and J. Sucher. May 1959 [9]p. incl. tables. (Technical rept. no. 136) (AFOSR-TN-59-567) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 216272 Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 463-470, June 1, 1959.

The ratio of Λ^0 to Σ^0 production in the absorption of Σ^0 particles in deuterium is calculated, using the experimental value of the same ratio for absorption in hydrogen. It is assumed that the capture always takes place in S orbits, that the relative parity of Σ^- , Σ^0 and Λ^0 are even, and that the final state interaction can be neglected. For a value of the Σ^- , Σ^0 mass difference of greater than about 6 mev it is possible to obtain agreement with experiment. Any enhancement of the Λ^0 production, similar to that which exists for K^- absorption in deuterium, would make agreement harder to obtain.

910

Maryland U. Dept. of Physics, College Park.

ON THE SUPPRESSION OF P-STATE CAPTURE IN (K^- , p) ATOMS, by T. B. Day, G. A. Snow, and J. Sucher. June 1959, 10p. incl. table, refs. (Technical rept. no. 137) (AFOSR-TN-59-606) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 217393 Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 61-64, July 1, 1959. (Title varies)

Reactions of K^- mesons at rest in liquid hydrogen or deuterium are studied. It is pointed out that successive Stark effect collisions of a highly excited (K^- , p) atom with nearby protons in the liquid hydrogen will drastically reduce the probability that the K^- meson ever reaches the 2P orbit. Calculations indicated that of the K^- mesons captured by protons in liquid hydrogen in highly excited states $\leq 1\%$ will ever reach the 2P level. This result implies that when a K^- meson comes to rest in

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liquid hydrogen, the nuclear capture reaction essentially always occurs with the relative orbital angular momentum of the (K^-, p) system equal to zero.

911

Maryland U. Dept. of Physics, College Park.

AN ATTEMPT AT UNIVERSAL FOUR-FERMION INTERACTION, by J. C. Pati and S. Oneda. June 1959, 45p. incl. diagrs. tables, refs. (Technical rept. no. 139) (AFOSR-TN-59-630) (AF 49(635)24) AD 218820; PB 144429 Unclassified

Also published in *Nuovo Cimento, Series X*, v. 16: 365-367, Apr. 1, 1963.

An attempt is made to explain the various decays of strange particles on the basis of vector and axial-vector 4-fermion interaction. The existence of $(V + A)$ currents as well as $(V - A)$ currents is considered as a possibility and the interaction is assumed to have the form $f(J_\alpha^{(+)} J_\alpha^{(+)*} + J_\alpha^{(-)} J_\alpha^{(-)*}) + h.c.$, where f is the coupling constant, $J_\alpha^{(-)}$ is composed of all charged currents which have negative chirality, $\bar{A}\gamma_\alpha(1 + \gamma_5)B$, and $J_\alpha^{(+)}$ of those charged currents which have positive chirality, $\bar{C}\gamma_\alpha(1 - \gamma_5)D$. The leptonic currents necessarily belong to the $J_\alpha^{(-)}$ group since the neutrino has a negative helicity. The appropriate assignment of chiralities to various possible charged baryonic currents has been studied in order to explain the characteristics of hyperon decays in the framework of global symmetry for the pion interactions. The virtual pionic or kaonic effects outside the loop are neglected. Results show that there are 3 solutions which can explain reasonably well the branching ratios and asymmetry parameters of hyperon decays. One of the solutions seems to be the best since it explains rather well the rates of hyperon decays and $\pi \rightarrow l + \nu$ decay at the same time. Signs of asymmetry parameters of hyperon decays are important to distinguish these solutions. (Contractor's abstract)

912

Maryland U. Dept. of Physics, College Park.

COLLISIONAL AUGER PROCESS FOR MU-MESIC ATOMS, by T. B. Day and J. Sucher. July 1959, 7p. (Technical rept. no. 143) (AFOSR-TN-59-771) (AF 49(638)24) AD 220578; PB 143157 Unclassified

An attempt is made to evaluate the cross section for the collisional de-excitation of a μ -mesic Li atom in Li which was estimated by Day and Morrison (Phys. Rev., v. 107: 912, 1957) as $\sim \pi a_0^2$, where a_0 is the Bohr ra-

dius. Bernstein and Wu (Phys. Rev. Ltrs., v. 2: 404, 1959) criticized the suggestion by Day and Morrison that de-excitation of a μ -mesic atom might occur by a collision with another atom, wherein an electron of the other atom takes off the released energy. The criticism was based on the observation that the cross section for this process could not be very different from the corresponding one for de-excitation of an excited atom by inelastic scattering of a free electron. Results show that the estimation of Day and Morrison is too large by almost an order of magnitude. The conclusion of Bernstein and Wu appears valid that the formula for the cross section for the collisional de-excitation does correspond to the formula for the cross section for the inelastic scattering of a free electron by a μ -mesic atom. (ASTIA abstract)

913

Maryland U. Dept. of Physics, College Park.

K^- -NUCLEON SCATTERING LENGTHS AND THE K^- -d SCATTERING REACTIONS, by T. B. Day, G. A. Snow and J. Sucher. July 1959 [18]p. incl. diagr. tables, refs. (Technical rept. no. 142) (AFOSR-TN-59-772) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 220579; PB 144038 Unclassified

Also published in *Nuovo Cimento, Series X*, v. 14: 637-648, Nov. 1, 1959.

The K^- -d elastic and total cross sections are calculated, using a model which includes multiple scattering effects. The scattering lengths which Dalitz and Tuan (Phys. Rev. Ltrs., v. 2: 425 (1959)) find as fits to the K^- -p data are used in an attempt to distinguish between the 4 possible solutions. The impulse approximation fails to give sensible results in this problem. (Contractor's abstract)

914

Maryland U. Dept. of Physics, College Park.

AN ASYMPTOTIC CAUSALITY REQUIREMENT FOR SYSTEMS WITH CONSTRAINED INPUTS, by J. Sucher. July 1959, 12p. (Technical rept. no. 141) (AFOSR-TN-59-773) (AF 49(638)24) AD 220577; PB 143156 Unclassified

Also published in *Nuclear Phys.*, v. 14: 263-269, Dec. 1959.

The usual formulation of causality for simple linear systems: "no output before input", may fail to imply that the system kernel, $K(\tau)$, is a causal function of the time delay τ , because the class of physically admissible input functions may not contain a complete set of causal signals. An attempt is made to formulate a causality requirement, asymptotic in nature, which overcomes this difficulty. It is found, rather generally, that systems

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which satisfy this requirement cannot have a finitely acausal kernel. If it could be shown that the kernel cannot be infinitely acausal, the validity of the usual dispersion relations for such systems would be ensured. (Contractor's abstract)

915

Maryland U. Dept. of Physics, College Park.

K⁻-NUCLEON SCATTERING LENGTHS AND THE K⁻-d INELASTIC CROSS SECTION, by T. B. Day and J. Sucher. July 1959, 7p. incl. table, refs. (Technical rept. no. 146) (AFOSR-TN-59-819) (AF 49(638)24) AD 225919; PB 143640 Unclassified

The K⁻-d inelastic cross sections are calculated in order to verify the heuristic estimation arrived at from results of a former paper. The measurement of the total elastic scattering cross section for K⁻ meson on deuterons has been hindered by the difficulty in separating out the inelastic, "break-up" events. The results are presented in table form, and show that the calculated and estimated values are consistent.

916

Maryland U. Dept. of Physics, College Park.

ON THE LEPTONIC DECAY MODES OF K-MESON, by K. Chadan and S. Oneda. Aug. 1959, 10p. incl. diagrs. refs. (Technical rept. no. 151) (AFOSR-TN-59-877) (AF 49(638)24) AD 226348; PB 143639 Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 292-295, Sept. 15, 1959. (Title varies)

An investigation is undertaken regarding how far the so-called V-A Fermi interaction can account for the strangeness non-conserving weak reactions. It has been noticed that the observed rates of the decays

$K^0 \rightarrow \pi^+ + e^- + \bar{\nu}$ and $K^+ \rightarrow \pi^0 + e^+ + \nu$ seem to be anomalously small compared with the universal rates. Using a dispersion technique, it is conjectured that the rate of $K \rightarrow \mu + \nu$ decay is not in contradiction with the experimentally indicated slow rates of hyperon decays into leptons.

917

Maryland U. Dept. of Physics, College Park.

HYPERFRAGMENT FORMATION FOR THE K⁻-DEUTERON INTERACTION IN FLIGHT, by T. B. Day, G. A. Snow, and J. Sucher. [1959] 8p. incl. diagr. table. (Technical rept. no. 154) (AFOSR-TN-59-1072) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 228578; PB 144343 Unclassified

This note estimates the percentage of the K⁻-d reactions of the type $K^- + d \rightarrow \Sigma^- + n + \pi^+$ which results in a bound (Σ^- , n) system, presumably bound in an S state. The results, presented in table form, show that the hope of observing hyperfragment formation in deuterium bubble chambers is not bright. The results imply that the (Σ^- , n) hyperfragment production cross section at the momenta calculated will be ≤ 0.1 mb.

918

Maryland U. Dept. of Physics, College Park.

HIGH ORBITAL S-STATE CAPTURE OF π^- -MESONS BY PROTONS, by T. B. Day, G. A. Snow, and J. Sucher. [1959] 8p. incl. refs. (Technical rept. no. 159) (AFOSR-TN-59-1295) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)24 and Atomic Energy Commission under AT(40-1)2504) AD 230914; PB 145643 Unclassified

Also published in Phys. Rev., v. 118: 864-866, May 1, 1960.

The consequences of the very short capture time for π^- mesons in liquid hydrogen, recently measured by Fields, Yodh, Derrick, and Fetkovich, are discussed. It is pointed out that collisional de-excitation mechanisms, even including the Stark effect enhancement of capture, seem inadequate to explain the experiment. Alternative possibilities are discussed.

919

Maryland U. Dept. of Physics, College Park.

VARIATIONAL APPROACH TO THE MANY-BODY PROBLEM USING DENSITY MATRICES (II), by R. U. Ayras. Dec. 1958, 18p. (Technical rept. no. 127) (AFOSR-TN-59-64) (AF 49(638)399) AD 210184 Unclassified

The variational approach to the quantum many-body problem is considered further, with particular emphasis upon the hierarchy of distribution functions which are derivable from the "reduced density matrices" of L6wdin (Phys. Rev., v. 97: 1474, 1955) and Mayer (Phys. Rev., v. 100: 1574, 1955). Corrections to the Hartree-Fock energy are obtained for a system of particles interacting with a screened Coulomb interaction. The results are left in terms of one unknown parameter, which is determined by a very complicated integral condition. The problem has not yet been evaluated in practice, due to the analytic difficulty.

920

Maryland U. [Dept. of Physics] College Park.

THE EFFECT ON SUPERCONDUCTIVITY OF AN INTERACTION BETWEEN CONDUCTION AND 4f

AIR FORCE SCIENTIFIC RESEARCH

ELECTRONS, by J. Peretti and A. A. Maradudin. Mar. 1959 [64]p. incl. diagrs. refs. (Technical note no. BN-166) (AFOSR-TN-59-383) (AF 19(600)1315 and AF 49-(638)399) AD 214010; PB 140524 Unclassified

Presented at meeting of the Amer. Phys. Soc., Massachusetts Inst. of Tech., Cambridge, Mar. 30-Apr. 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 149, Mar. 30, 1959. (Title varies)

Alloying lanthanum with the paramagnetic rare earth metals decreases the superconductive transition temperature by an amount ΔT_c which depends on the concentration and the total spin of the solute atom. An attempt is made to explain this behavior by considering the Coulomb interaction of conduction electrons with the 4f inner electrons of the solute atoms. Various effects of this interaction are taken into account. The result is that ΔT_c is nearly proportional to the solute concentration and depends on the total spin in a rather complicated way. The 2nd and all higher order terms in the perturbation expansion for the thermodynamic functions do not affect the value of the transition temperature. The T_c decrease arises solely from the coulomb exchange interaction of the zero order. The solution of the complete integral equation for the variation of the energy gap with temperature and Δ was carried out and results plotted. The energy gap at any temperature below $T_c^{(0)}$ is lowered by the exchange interaction. (ASTIA abstract)

921

Maryland U. Dept. of Physics, College Park.

A REMARK ON THE MEISSNER EFFECT AND THE THEORY OF PERFECTLY FREE ELECTRONS, by J. Peretti. June 1959, 3p. (Technical rept. no. 140) (AFOSR-TN-59-554) (AF 49(638)399) AD 216719; PB 142604 Unclassified

It is shown that by considering a causality requirement, the Meissner effect can be deduced from the assumption that the superconducting electrons behave as if they are free. The equation for the Meissner effect is arrived at by assuming the current to be linearly dependent on the electric field and to be "caused" by the field.

922

Maryland U. Dept. of Physics, College Park.

SUGGESTED PAIR DISTRIBUTION FUNCTION FOR STRONGLY INTERACTING PARTICLES, by R. [U.]

Ayres. May 1959, 23p. incl. diagrs. (Technical rept. no. 134) (AFOSR-TN-59-624) (AF 49(638)399) AD 217688 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 14, Jan. 28, 1959. (Title varies)

A simple treatment of the many-body problem is given using standard methods, but especially emphasizing the connection between the 2-body distribution functions in momentum space and configuration space. With the results obtained 1st order energies are reproduced of the hard-sphere, "soft-sphere", square-well and Lennard-Jones gases that obey Fermi or Bose statistics.

923

Maryland U. Dept. of Physics, College Park.

VIBRATIONAL THERMODYNAMIC PROPERTIES OF LATTICES WITH DEFECTS, by J. Mahanty, Aug. 1959, 95p incl. diagrs. refs. (Technical rept. no. 145) (AFOSR-TN-59-758) (AF 49(638)399) PB 143880 Unclassified

Some techniques are developed for evaluating the changes in the vibrational properties of a lattice due to the presence of defects, and they have been applied to the study of the effect of defects on some lattice models. The techniques are based on the work of Montroll who has given a method for obtaining integral expressions for the change due to defects in an additive function of the normal mode frequencies of a lattice. The integral expressions for the changes in vibrational thermodynamic properties are contour integrals of functions whose poles are distributed in such a way that integration becomes inconvenient. It is shown that if the evaluation of the change in thermodynamic properties at low and high temperature is restricted, the need for integrating over such singular functions can be avoided by using some special devices. These devices lead to some useful formulas which are employed in the study of the effect of isotope and substitutional impurities in 1, 2, and 3 dimensional lattices with nearest neighbor central and noncentral force interactions. Results are given for the low and high temperature values of the change in Helmholtz free energy due to defects in these cases. Methods for extending the applicability of these techniques to the case of more complicated lattices are indicated, and the discrete frequencies that arise due to an isotope defect in lattices with coupled displacement components are computed. (Contractor's abstract)

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Maryland U. Dept. of Physics, College Park.

QUASI-PARTICLE APPROACH TO INTERACTION IN

AIR FORCE SCIENTIFIC RESEARCH

AN IDEALIZED METAL, by J. J. Quinn and R. A. Ferrell. Sept. 1959, 24p. incl. diagrs. refs. (Technical rept. no. 156) (AFOSR-TN-59-1246) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)399 and Office of Naval Research under Nonr-179700) AD 229342; PB 148890 Unclassified

Presented at the Internat'l. Plasma Physics Inst., Seattle Wash., Sept. 1959.

Also published in Jour. Nuclear Energy, Pt. C, v. 2: 18, 1961.

The properties of a degenerate electron gas with a background of positive charge capable of propagating phonons are studied by means of a quasi-particle approach. The ground state of the system is pictured as a vacuum state, and any additional particles or holes together with their polarization clouds are thought of as quasi-particles. The Coulomb repulsion and the effective electron-electron attraction due to phonon exchange are treated separately. The specific heat, spin susceptibility, and compressibility are determined in terms of the effective energy of interaction $V_{pp'}$ of 2 quasi-particles. Considering only the lowest order process contributing to $V_{pp'}$ reproduces known results for the high density limit Coulomb correction to the specific heat and spin susceptibility, but gives a new result for the phonon correction. To lowest order, the electron-phonon interaction produces no change in the spin susceptibility, in contrast to general expectation. For real metallic densities higher order graphs must be included; however for this case it may be possible to choose $V_{pp'}$ empirically. (Contractor's abstract)

925

Maryland U. [Dept. of Physics] College Park.

CORRELATION ENERGY AND PAIR DISTRIBUTION FUNCTION FOR A DEGENERATE ELECTRON GAS (Abstract), by A. J. Glick and R. A. Ferrell. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)399], Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 14, Jan. 28, 1959.

The interaction energy of an electron gas can be expressed in terms of the Fourier transform $P(k)$ of the pair distribution function $g(r)$. Using first-order perturbation theory to calculate $P(k)$ leads to the well-known logarithmic divergence in the correlation energy. The calculation can be improved by expressing $P(k)$ in terms of the dynamic dielectric constant for the electron gas. Going to the limit of high density leads

to the Gell-Mann-Brueckner result. The advantage of working explicitly with the pair distribution function is that there exist general criteria for checking the validity of approximate calculations for the case of arbitrary density. $P(k)$ and $g(r)$ must both satisfy positive definiteness criteria since $P(k)$ is related to the cross section for scattering fast charge particles and $g(r)$ is a probability density. $g(r)$ is further restricted in that the value of $\int g(r) d^3r$ is assigned a priori.

926

Maryland U. Dept. of Physics, College Park.

[A REMARK ON PAULI PARAMAGNETISM FOR AN ELECTRON SYSTEM] Remarque sur le paramagnetisme de Pauli d'un gaz d'electrons, by J. Peretti. [1959] [2]p. [AF 49(638)399] Unclassified

Published in Compt. Rend. Séances Acad. Sci., v. 248: 1303-1304, Mar. 2, 1959.

It is shown that the Pauli paramagnetism of an electron gas is not entirely determined when purely electrostatic interactions is taken into account. (Contractor's abstract)

927

Maryland U. Dept. of Physics, College Park.

[EVALUATION OF THE PAIR DISTRIBUTION FUNCTION FOR AN IMPERFECT QUANTUM GAS. GENERAL METHOD] Évaluation de la fonction de distribution binaire d'un gaz quantique imparfait. Méthode générale, by L. Colin and J. Peretti. [1959] [4]p. [AF 49(638)399] Unclassified

Published in Compt. Rend. Seances Acad. Sci., v. 248: 1625-1628, Mar. 16, 1959.

A general method is indicated permitting the evaluation of the pair distribution function $p(\vec{r}_1, \vec{r}_2)$ as a function of the temperature T and fugacity z . This method requires the calculation of the generalized distribution integral $A^{(2)}(\vec{r}_1, \vec{r}_2)$. (Contractor's abstract)

928

Maryland U. [Dept. of Physics] College Park.

VIBRATION FREQUENCIES OF DEFECT MODES FOR LATTICES WITH COUPLED DISPLACEMENT COMPONENTS (Abstract), by J. Mahanty and A. A. Maradudin. [1959] [1]p. [AF 49(638)399] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

AIR FORCE SCIENTIFIC RESEARCH

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 143, Mar. 30, 1959.

All calculations up to the present time of the frequencies of localized modes of vibration associated with defects in a crystal have been carried out either for the longitudinal vibrations of linear chains or for physically unrealistic models of 2- and 3-dimensional lattices where the x, y, and z-components of displacement are uncoupled. The usual methods for calculating these frequencies cannot be used in the case of lattices with coupled displacement components. The frequencies of the localized modes due to a light isotope defect in a monatomic linear chain in which the particles have coupled longitudinal and transverse displacement components have been calculated by a study of the analytic properties of the secular determinant in the complex frequency plane. A single frequency emerges from the top of each of the 2 bands of the frequency spectrum, and each varies quadratically with the strength of the defect. Applications of this method to 2- and 3-dimensional lattices will be discussed.

929

Maryland U. [Dept. of Physics] College Park.

VIBRATIONAL FREQUENCY SPECTRA OF TWO-DIMENSIONAL LATTICES WITH COULOMB LATTICES (Abstract), by J. A. Davies and A. A. Maradudin. [1959] [1]p. [AF 49(638)399] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 143, Mar. 30, 1959.

The frequency spectra of a 2-D monatomic lattice with Coulomb interactions plus nearest neighbor repulsive forces have been calculated for the cases of 1 and 2 degrees of freedom per lattice point. In the former case the vibrations are taken to be normal to the plane of the lattice. The frequency spectrum contains 2 logarithmic infinities and a discontinuity in slope not found in short-range force models. The latter singularity is associated with a critical point at which $\text{grad } \omega^2 \neq 0$. The 2nd model differs from that studied by Smollett only in the range of the non-Coulomb forces. The constant frequency curves are qualitatively the same as obtained by Smollett, but the frequency spectrum contains a logarithmic infinity, 2 jump discontinuities not located at the end points, and a discontinuity in slope in addition to the singularities found by Smollett.

930

Maryland U. [Dept. of Physics] College Park.

ROTATIONAL ENERGY LEVELS IN DIATOMIC MOLECULAR CRYSTALS (Abstract), by B. J. Castle. [1959] [1]p. [AF 49(638)399] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 162, Mar. 30, 1959.

Crystals of CO and N₂ exhibit transitions from one solid form to another at 61.6°K and 35.6°K, respectively. The prediction of these transition temperatures on the basis of classical self-consistent calculations employing the intermolecular potential has been discussed by Jansen and de Wette whose results are in good agreement with experiment. The Schrödinger equation for the rotational eigenstates of the molecules in the low-temperature structures, with the inclusion of a potential which is believed to be a good representation of the crystal field, has as eigenfunctions oblate spheroidal wave functions. The separation of the lowest lying rotational energy levels is not small enough to justify the assumption of a Boltzmann distribution for the diatomic rotors below the transition point. The partition function for the rotational states has therefore been calculated quantum mechanically for the region in which the classical approximation is deemed invalid, taking two shells of neighbors about a central molecule into account, and including the effect of nuclear spin in the case of N₂. The results for the transition temperatures will be discussed.

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Maryland U. [Dept. of Physics] College Park.

ELASTIC CONSTANTS OF SOLID ARGON AT 0°K (Abstract), by R. M. Winter and A. A. Maradudin. [1959] [1]p. [AF 49(638)399] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 226, Apr. 30, 1959.

The vibrational Helmholtz free energy of a crystal at low temperatures separates into the zero-point energy and a temperature-dependent part. If the lattice is strained both of these depend on the strain parameters and hence contribute to the elastic constants. Calculations were made on the zero-point energy contributions to the elastic constants of solid argon using a Lennard-Jones 6-12 potential with nearest neighbor interactions only. In the quasi-harmonic approximation, the potential energy of the strained lattice is expanded to quadratic terms in the displacements of the atoms from their equilibrium positions, but the force constants now depend on the strain parameters. Using the moment-trace method, calculations were made on the even moments of the frequency spectrum (up to μ_{10}) for a strained lattice as functions of the strain parameters, and used in inverse Lagrange interpolation to obtain μ_1 , which is proportional to the zero-point energy. The corrections to

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the elastic constants for the static lattice are of the order of 10% in each case, and the Cauchy relation $c_{12} = c_{44}$ is not satisfied at 0°K.

932

Maryland U. [Dept. of Physics] College Park.

EVALUATION OF THE PAIR DISTRIBUTION FUNCTION FOR A HARD SPHERE BOSE GAS (Abstract), by L. C. Scherer and J. Peretti. [1959] [1]p. [AF 49(638)-399] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 244, Apr. 30, 1959.

The pair distribution function for a quantum system is expressed as a power series of the fugacity, the coefficients of which are temperature dependent. For the hard sphere case these coefficients have been calculated to the first order in a/λ (where a is the scattering length of the interacting potential and λ the thermal wavelength) using torons with two fixed points or alternatively U functions.

933

Maryland U. Dept. of Physics, College Park.

[CHANGE OF THE TRANSITION TEMPERATURE OF SUPERCONDUCTING ALLOYS OF LANTHANUM AND OTHER RARE EARTH METALS WITH THE SPIN OF THE SOLUTE ATOM] Variation de la température de transition des alliages supraconducteurs du lanthane et des autres terres rares avec le spin du soluté, by A. [A.] Maradudin and J. Peretti. [1959] [3]p. incl. diagr. [AF 49(638)399] Unclassified

Published in Compt. Rend. Séances Acad. Sci., v. 248: 2856-2858, May 20, 1959.

Recent experiments have shown that the transition temperature of superconducting lanthanum is lowered when a determined fraction of lanthanum atoms is replaced by 2 rare earth impurities, by a quantity depending on the spin of the atom and on the exchange between the conduction and the 4f electrons. This report explains this effect.

934

Maryland U. Dept. of Physics, College Park.

DIELECTRIC CONSTANT AND PAIR DISTRIBUTION FUNCTION OF THE DEGENERATE ELECTRON GAS (Abstract), by A. J. Glick. [1959] [1]p. (Bound with its AFOSR-1856) (AF 49(638)399) Unclassified

The degenerate electron gas is studied by means of its dielectric constant and pair distribution function. Kramers-Kronig relations and sum rules for the dielectric constant are derived from the principle of causality. With these relations it is possible to determine the entire dielectric constant once its imaginary part is known. A dielectric constant, valid in the random phase approximation, is found in a way that complements Lindhard's determination of the same quantity. In the dielectric formulation, the properties of this mode are shown to be completely determined by the spectrum of single particle excited states. A study of the scattering of fast particles by the electron gas suggests that continuum excitations might be experimentally observable in the related case of electrons passing through thin metal films. The effective screening of the long range Coulomb interaction by the electrons in the system is exhibited by a study of the pair distribution function. An analysis of the ferromagnetic state of the electron gas leads to a strong integral restriction on the pair distribution function. The random phase approximation is found to violate this restriction. Adding an exchange correction gives a satisfactory distribution function, and leads to the same correlation energy. In an attempt to go beyond the random phase approximation the dielectric constant is re-defined in terms of a scattering cross section. With the new definition a theory is constructed which presents a means of calculating the dielectric constant more accurately.

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Maryland U. Dept. of Physics, College Park.

PROPERTIES OF THE UPPER ATMOSPHERE DEDUCED FROM THE RADIATION BELT, by S. F. Singer. [1959] [22]p. incl. diagrs. refs. (AFOSR-TN-59-158) (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)5575 and Air Force Office of Scientific Research under AF 49(638)530) AD 211117; PB 142708 Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 4-7, 1959.

Abstract published in I.R.E. Trans. of Professional Group on Antennas and Propagation, v. AP-7: 283, July 1959.

Also published in Planetary and Space Sci., v. 2: 165-173, Apr. 1960.

A new theory was developed which gives the distribution of density with altitude for a planetary exosphere in the absence of the thermodynamic equilibrium. A level of altitude is reached at which the density of the atmosphere is so low that the mean free path becomes of the order of the scale height. The theory is applied to the exosphere by fixing the temperature of the base at 530 km and by using satellite drag data between 500 and 1000 km. The upper limit is set at about 10^6 H atoms per cm^3 at an altitude of 1000 km from the cosmic

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ray neutron albedo theory of the inner radiation belt. The existence of a minimum (slot) between the 2 observed radiation belts is accounted for in terms of the breakdown of the adiabaticity of the magnetic moment of trapped particles. The initial injection of solar corpuscular radiation consists mainly of protons and electrons with velocities of 2×10^8 cm/sec. These 20 kev protons form a third and rather transient radiation belt at 4-8 earth radii and account for most of the effects observed during magnetic storms.

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Maryland U. Dept. of Physics, College Park.

FARADAY ROTATION OF RADIO WAVES WITHIN THE CRAB NEBULA, by H. Laster and A. M. Lenchek. Feb. 1959 [4]p. incl. refs. (AFOSR-TN-59-164) (AF 49(638)530) AD 211144; PB 144029 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 66, Jan. 28, 1959. (Title varies)

Mayer has observed a polarization of about 7% for microwaves of 9500 mc emitted from Crab Nebula. This compares with mean polarizations of about 17% and more for continuous light observed by Oort and Walraven. If polarization of the continuous emission is caused by synchrotron radiation as has been suggested, many factors tend to lower the polarization for lower frequencies. One important factor is Faraday rotation. The existence of polarization at 9500 mc sets upper limits on the average of the product of magnetic field times ionization within the Crab Nebula. The ionization can be estimated and upper limits therefore places on the total magnetic energy in the Crab. Since the limits depend upon certain assumptions about the structure of the field, validity of these assumptions is discussed.

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Maryland U. Dept. of Physics, College Park.

RADIOWAVE PROPAGATION IN INTERPLANETARY MAGNETIC FIELDS, by A. M. Lenchek. Jan. 1959 [25]p. incl. diagrs. table, refs. (Technical note no. 113) (AFOSR-TN-59-165) (AF 49(638)530) AD 211144 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 66, Jan. 28, 1959. (Title varies)

The measurement of intensities of molecular band systems is often complicated by the partial overlapping of

adjacent bands, making the direct measurement of integrated total band intensities extremely difficult, if not impossible. Several attempts have been made by various authors to overcome the problem, none being generally applicable. Two general methods are suggested here. In the 1st a known fraction of the band is employed, and in the 2nd the rotational intensity distribution within a band is interpreted in terms of the total band intensity. The methods have been tested experimentally and found to be in good agreement for the NO β and O₂⁺ second negative systems where the integrated intensities were independently measured. (Contractor's abstract)

938

Maryland U. [Dept. of Physics] College Park.

THEORY OF THE COSMIC-RAY RADIATION BELT: ALTITUDE, LATITUDE, AND ENERGY DISTRIBUTION (Abstract), by S. F. Singer, H. Griem, and R. C. Wentworth. [1959] [1]p. (AFOSR-TN-59-166) [AF 49(638)530] AD 211145 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 7, Jan. 28, 1959.

The intensity of the radiation follows from a balance of the rates of injection into trapped orbits with the rate of removal from such orbits. A discussion of the lifetime of electrons and protons in the exosphere and of the possible injection mechanisms indicates that cosmic ray albedo neutrons should be the dominant source at low and intermediate latitudes; they provide decay protons with energy up to a few hundred mev. The lifetime of these protons is mainly determined by collision loss. Angle scattering is negligible and the intensity can therefore be obtained from the production rate by integration over the orbits. In this report directional and omnidirectional differential and integral intensities are calculated for latitudes up to 45° and altitudes to two earth radii. The proposed mechanism may be adequate to explain the observed intensities except for the fringe regions where probably injection from solar corpuscular beams is the dominant production mechanism and adds an auroral (soft) radiation belt.

939

Maryland U. Dept. of Physics, College Park.

LIFETIMES OF TRAPPED AURORAL RADIATION BELT PARTICLES. PART I. EFFECT OF SCATTERING BY THE IONIZED COMPONENT OF THE OUTER ATMOSPHERE, by R. C. Wentworth, W. M. MacDonald, and S. F. Singer. Mar. 1959 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-59-167) (Sponsored jointly by

AIR FORCE SCIENTIFIC RESEARCH

AFCRC Geophysical Research Directorate under
AF 19(604)3861 and Air Force Office of Scientific Research under AF 49(638)530 AD 211146

Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II,
v. 4: 7, Jan. 28, 1959.

Also published in Phys. Fluids, v. 2: 499-509, Sept.-Oct.
1959. (Title varies)

The existence of trapped protons and electrons in the earth's magnetic field was discussed in connection with a theory of magnetic storms, and was demonstrated in rocket flights to altitudes of several earth radii. Once introduced into captive orbits, these particles should be strictly trapped in the earth's dipole magnetic field. However, various mechanisms exist which limit their lifetimes, such as collisions with atoms and ions in the earth's outer atmosphere, charge exchange, and scattering by hydromagnetic waves. The effect of the scattering of these particles by the ionized hydrogen and electron components of the outer atmosphere is considered. The Fokker-Planck equation was used to derive an expression for the change in the distribution function due to small-angle, single particle Coulomb collisions. Upper lifetime limits, as determined by this mechanism, of both protons and electrons are derived as functions of their initial nonrelativistic energies. (Contractor's abstract)

940

Maryland U. Dept. of Physics, College Park.

SOME ASPECTS OF A THREE-BODY PROBLEM, by
G. K. Oertel and S. F. Singer. Mar. 1959, 21p. incl.
diags. (AFOSR-TN-59-405) (AF 49(638)530)
AD 214502; PB 140501

Unclassified

Also published in Astronaut. Acta, v. 5: 356-366, 1959.

A special case of the restricted three-body problem of celestial mechanics, namely the motion of a particle in the field of two non-rotating mass centers whose separation remains fixed is considered. Applying a formalism developed by Charlier, limits for the motion of this small mass and give, in particular, the equations for the ellipses in terms of the constants of motion are derived. Especially simple expressions have been derived for a particular choice of initial conditions. Interestingly, the equations of the two limiting ellipses do not depend on how the total mass is distributed between the two centers of attraction; they depend only on the separation of the two centers. However, the rate at which the actual orbit traverses between the limiting ellipses does depend on the division of mass. For the case in which the two limiting ellipses coincide, the periodic case, the energy and also the equation of the orbit are independent of the distribution of the total mass

between the two centers, the energy being the Kepler energy for the particular orbit. The theory may be applied to discuss the motion of a satellite near a planet which has a large bulge or "bump".

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Maryland U. [Dept. of Physics] College Park.

DISTRIBUTION OF NEUTRAL HYDROGEN IN THE
EARTH'S EXOSPHERE (Abstract), by S. F. Singer.
[1959] [1]p. (AFOSR-TN-59-468) [AF 49(638)530]
AD 215227; AD 261668

Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
222, Apr. 30, 1959.

The exosphere is defined as the outermost region of a planetary atmosphere where collisions can be neglected and neutral atoms move in essentially free ballistic orbits. We derive their concentration as a function of altitude; it differs considerably from densities obtained by considerations of thermodynamic equilibrium. The new theory gives the correct value for the escape flux and for the density at infinity. We can now obtain numerical values for the lower exosphere of the earth by applying a theory of the cosmic ray radiation belt to counting rates observed in satellites by Van Allen et al. Combining with drag data from satellite orbits, we obtain a temperature of 1500°K at 530 km, the deduced base of the exosphere. The transition altitude (beyond which hydrogen takes over from oxygen as the most important constituent of the exosphere) turns out to be 1000 km. At this level the H-concentration is 3×10^6 per cm^3 and the total density 9×10^{-18} g/cm. Numerical results will be presented on neutral hydrogen densities out to several earth radii.

942

Maryland U. Dept. of Physics, College Park.

TRAPPED RADIATION IN THE EARTH'S MAGNETIC
FIELD, by S. F. Singer. Aug. 1959, 7p. incl. refs.
(AFOSR-TN-59-1028) (Sponsored jointly by Air Force
Cambridge Research Center as AFCRC-TN-59-763;
scientific rept. no. 2 under AF 19(604)5575 and Air Force
Office of Scientific Research as technical rept. no. 153
under AF 49(638)530) AD 227259; PB 144416

Unclassified

Also published in Proc. Fourth Internat'l. Conf. on Ionization Phenomena in Gases, Uppsala (Sweden) (Aug. 17-21, 1959), Amsterdam, North-Holland Publishing Co., 1960, p. 1187-1190.

Problems of injection, lifetime, and possible heating of plasmas in the earth's magnetic field are discussed.

AIR FORCE SCIENTIFIC RESEARCH

Injection can take place by (1) solar corpuscular streams which perturb the magnetic field, (2) means of neutrons which decay within the field, or (3) the direct release of charged particles within the earth's magnetic field. The behavior of the trapped particles shows many interesting features which are important for laboratory plasmas confined in a mirror geometry. Phenomena occur in naturally trapped plasmas such as (1) instabilities set up by trapped particles, their bunching and the emission of electromagnetic waves of low frequency; and (2) interaction between charged particles and hydromagnetic waves leading to particle acceleration which eventually manifests itself in the form of aurora. (Contractor's abstract)

943

Maryland U. Dept. of Physics, College Park.

PRESENT STATUS OF THE EARTH'S RADIATION BELT, by S. F. Singer. Sept. 1959, 6p. incl. table. (Technical rept. no. 155; Scientific rept. no. 3) (AFOSR-TN-59-1029; AFCRC-TN-59-766) (Sponsored jointly by AFCRC Electronics Research Directorate under AF 19(604)5575 and Air Force Office of Scientific Research under AF 49(638)530) AD 227260; PB 146274 Unclassified

Also published in Proc. Tenth Internat'l. Astronaut. Congress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959). Vienna, Springer-Verlag, v. 1: 390-393, 1960.

The present available observations on the geomagnetically trapped radiation are reviewed. The inner belt contains a large flux of high energy penetrating protons while the outer belt consists mainly of low energy electrons. The inner belt, therefore, is of considerable importance from a spacemedical point of view since shielding presents a real problem. The possible use of "sweeper satellites" to depress the intensity of the inner belt is discussed. The creation of artificial radiation belts by means of electrons injected from a rocket or satellite-borne accelerator is discussed in greater detail. Such artificial belts can be of great value for geophysical studies.

944

Maryland U. [Dept. of Physics] College Park.

CHARGE ON A BODY MOVING IN AN IONIZED ATMOSPHERE WITH PERVAIDING MAGNETIC FIELD (Abstract), by S. F. Singer and K. P. Chopra. [1959] [1]p. [AF 49(638)530] Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 360, Aug. 27, 1959.

A body moving in an ionized atmosphere with a pervad-

ing magnetic field may acquire charge through collisions with ions and electrons, photoejection of electrons, and induced electric currents due to the motion across the magnetic lines of force. The phenomena have different behaviors at slow and fast speeds of the body. In the intermediate case, the calculations would be quite involved. A knowledge of the nature and amount of charge on a body is of interest in the problems concerning the dynamics of dust particles, meteors and meteorites, whistling atmospherics, and indeed the motion of artificial earth satellites. The relative importance of the various processes of charging under specified conditions is discussed. Some insight can be gained by performing simple experiments in a low-density wind tunnel. The principle of design of a method of estimating satellite charge is briefly discussed.

945

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

AXISYMMETRIC FREE-CONVECTION TEMPERATURE FIELD ALONG A VERTICAL THIN CYLINDER (Abstract), by F. R. Hama, J. V. Recesso, and J. Christiaens. [1959] [1]p. [AF 18(600)1014] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 196, Mar. 30, 1959.

Also published in Jour. Aero/Space Sci., v. 26: 335-342, June 1959.

With a view to studying the effect of strong transverse curvature on boundary-layer problems, the axisymmetric free-convection problem along a vertical thin cylinder is investigated theoretically as well as experimentally. A theory is developed as an extension of the Pohlhausen solution of a thick axisymmetric laminar boundary layer by Mark and by Glauert and Lighthill. Experiments consist of a thermocouple survey of the temperature field over an electrically heated brass cylinder of 1/4 in. diam and 10-ft height and an interferometric study of the density field over a bare tungsten wire of 0.02-in. diam and 5-ft height. The thermal-layer thicknesses are about five and fifty times the radii of the cylinders, respectively. Experimental results of the local heat-transfer coefficient are in excellent agreement with the theory. This, in turn, justifies the theories of laminar boundary layer along a thin cylinder.

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SOME TRANSITION PATTERNS IN AXISYMMETRIC

AIR FORCE SCIENTIFIC RESEARCH

BOUNDARY LAYERS, by F. R. Hama. [1959] [4]p. incl. illus. [AF 18(600)1014] Unclassified

Published in Phys. Fluids, v. 2: 664-667, Nov.-Dec. 1959.

Direct observation of the vortex pattern caused by a ring-shaped trip is made on 1-in. and 1/2-in. circular cylinders and on a 30° cone in a water tank. Over the cylinders the boundary-layer thickness is approximately equal to the radius of the cylinders. Ring-shaped vortices are shed and deformed into vortex loops in the same manner as on a flat plate. On the cone the ring-shaped vortices are stretched and then inevitably deformed into vortex loops, indicating that a mere stretching is not a sufficient mechanism for the creation of a turbulence spot. A mechanism of the final breakdown from the vortex loop is tentatively proposed.

947

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE USE OF FOURIER TRANSFORMS FOR THE STUDY OF SINGULAR POINTS IN THE FREQUENCY SPECTRUM OF A CRYSTAL, by J. Peretti and A. [A.] Maradudin. Nov. 1958 [9]p. (Technical note no. BN-155) (AFOSR-TN-59-21) (AF 18(600)1315 and AF 49-(638)399) AD 208751; PB 138783 Unclassified

Also published in Compt. Rend. Séances Acad. Sci., v. 247: 2310-2311, Dec. 22, 1958.

A new method based on theorems relating to the asymptotic behavior of Fourier transforms is presented for determining the shape of vibrational frequency spectra in the immediate vicinity of their critical points. The method is illustrated by applying it to the determination of the shape of spectra due to analytic critical points for one-, two- and three-dimensional lattices. (Contractor's abstract)

948

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

AUXILIARY INTEGRALS FOR LATTICE SUMS, by A. A. Maradudin and G. H. Weiss. Dec. 1958, 11p. incl. tables. (Technical note no. BN-156) (AFOSR-TN-59-55) (AF 18(600)1315) AD 20942C Unclassified

Also published in Jour. Chem. Phys., v. 31: 1433, Nov. 1959.

The integrals

$$\phi_m(x) = \int_1^\infty t^m e^{-xt} dt$$

are tabulated for the following values of x and m: x = 0.2(0.2)20 and m = 0.5(1)12.5. (Contractor's abstract)

949

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

QUANTUM STATISTICS OF INTERACTING PARTICLES. II. CLUSTER INTEGRAL DEVELOPMENT OF TRANSPORT COEFFICIENTS, by E. W. Montroll and J. C. Ward. [1959] [21]p. incl. diagrs. refs. (AFOSR-TN-59-258) [AF 18(600)1315] AD 262052

Unclassified

Also published in Physica, v. 25: 423-443, June 1959.

A systematic cluster integral expansion has been developed for time relaxed pair distribution functions. Each cluster integral can be represented by a Feynman type diagram in $(r, \beta + i\hbar^{-1})$ space. By employing a formalism due to Kubo (Jour. Phys. Soc. Japan, v. 12: 570, 1957) such distribution functions are used to obtain cluster integral developments of transport coefficients. The transport coefficients are time integrals over time relaxed momentum correlation functions. Since the time integral of each cluster integral diverges, one must sum various sets of cluster integrals before integration. It is shown that in the classical limit, summation over 1 particular set of integrals is equivalent to solving the Boltzmann equation. Irreversibility enters naturally into the formalism through the introduction of grand canonical ensemble averages and passage to the limit as the number of particles and volume become infinite in such a way the N/V preserves the proper value for the density. (Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE CLUSTER INTEGRAL DEVELOPMENT OF PAIR DISTRIBUTION FUNCTIONS, by S. Fujita, A. Ishihara, and E. Montroll. Jan. 1959, 25p. incl. diagrs. (Technical note no. BN-163) (AFOSR-TN-59-260) (AF 18(600)1315) AD 264129 Unclassified

A general cluster integral formalism is developed for the calculation of the molecular pair distribution function. A hybrid between a Mayer graph and a Feynman diagram is associated with the cluster integrals. The formalism is used to derive the London-Placzek formula for the pair distribution function of perfect Bose-Einstein and Fermi-Dirac gases and the Debye-Hückel distribution function for a low density, electron gas. (Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON AN ASYMPTOTIC EXPANSION OCCURRING IN

AIR FORCE SCIENTIFIC RESEARCH

THE EVALUATION OF A LATTICE SUM, by G. H. Weiss and A. A. Maradudin. Apr. 1959, 3p. (Technical note BN-167) (AFOSR-TN-59-529) (AF 18(600)-1315) AD 216536
Unclassified

Also published in *Canad. Jour. Phys.*, v. 37: 965-966, Aug. 1959.

A simple derivation of an asymptotic expansion which occurs in the evaluation of certain lattice sums is presented. An alternative to the Poisson summation formula is used which is the Euler summation formula.

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

INTEGRATION IN FUNCTIONAL SPACES AND ITS APPLICATIONS IN QUANTUM PHYSICS, by I. M. Gel'fand and A. M. Yaglom, tr. by A. A. Maradudin. May 1959, 51p. incl. refs. (Technical note no. BN-171) (AFOSR-TN-59-552) (AF 18(600)1315) AD 216692
Unclassified

Also published in *Jour. Math. Phys.*, v. 1: 48-69, Jan.-Feb. 1960 (trans. from *Uspekhi Matem. Nauk*, v. 11: 77-114, Jan. 1956).

In a translation from Gel'fand and Yaglom's article (*Uspekhi Matematicheskikh Nauk*, v. 11: 77-114, Jan. 1956) an attempt is made to throw light on the question of the utilization of methods of measure theory and integration in functional spaces into quantum physics. Certain mathematical questions connected with this application are examined.

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE PAIR DISTRIBUTION FUNCTION OF A BOSE HARD SPHERE SYSTEM, CALCULATED TO THE FIRST ORDER OF THE SCATTERING LENGTH, by L. [S.] Colin and J. Peretti. July 1959 [46]p. incl. diagrs. (Technical note no. BN-179) (AFOSR-TN-59-739) (AF 18(600)1315) AD 220036; PB 142990
Unclassified

Also published in *Nuovo Cimento, Series X*, v. 14: 233-234, Oct. 1, 1959.

Using the binary collision expansion method, the expression is derived of the pair distribution function of a system of Bose particles interacting via a hard sphere potential of radius a , up to the 1st order in a/λ . A general formula is used relating the pair distribution function in the grand canonical ensemble to certain generalized cluster integrals. The evaluation of these cluster integrals up to the 1st order in a/λ is achieved by using the diagrammatical analysis of the cluster func-

tions of the binary collision expansion method, which is equivalent to this order with the method of t-roads. (Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

[VARIATION OF THE TRANSITION TEMPERATURE OF SUPERCONDUCTING ALLOYS OF LANTHANUM AND OTHER RARE EARTH METALS WITH THE SPIN OF THE SOLUTE] Variation de la température de transition des alliages supraconducteurs du lanthane et des autres terres rares avec le spin du soluté, by A. [A.] Maradudin and J. Peretti. [1959] [3]p. incl. diagr. (AFOSR-TN-59-804) (AF 18(600)1315) Unclassified

Also published in *Compt. Rend. Séances Acad. Sci.*, v. 248: 2856-2858, May 1959.

Recent experiments of B. T. Matthias et al. (*Phys. Rev. Ltrs.*, v. 1: 98; 449, 1958.) have shown that the transition of superconducting lanthanum is lowered by the addition of rare earth impurities by a quantity depending on the spin of the atom and on the exchange between the conduction and the 4f electrons.

955

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

COMPARISON OF THE PAIR THEORY AND THE QUASI-PARTICLE METHOD FOR THE EVALUATION OF THE PROPERTIES OF AN INTERACTING BOSE SYSTEM, by J. Peretti. Aug. 1959 [12]p. incl. diagrs. (Technical note no. BN-182) (AFOSR-TN-59-850) (AF 18(600)1315) AD 225194; PB 143153
Unclassified

The connection is investigated existing between the theories of Lee, Huang and Yang (*Phys. Rev.*, v. 106: 1135-1145, June 15, 1957) and those of Boboliubov for the interacting Bose systems. The comparison is performed so that any physical quantity calculated in 1 of the 2 formalisms can be transcribed very easily in the other. Any physical quantity can be evaluated with the formalism which seems the more appropriate for this purpose. (Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE PAIR DISTRIBUTION FUNCTION OF A HARD SPHERE BOSE SYSTEM CALCULATED BY THE PSEUDO-POTENTIAL METHOD, by L. S. Colin. Sept. 1959 [38]p. incl. diagrs. tables. (Technical note no. BN-185) (AFOSR-TN-59-928) (AF 18(600)1315) AD 226857
Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in Jour. Math. Phys., v. 1: 87-96, Mar.-Apr. 1960.

The pair distribution function for a system of hard sphere bosons was performed replacing the hard sphere potential by the pseudo-potential. The problem was continued using the quasi-particle formalism of Bogoliubov. In this calculation, a system of bosons interact via the pseudo-potential, and is regarded as a weak interaction when the system is very dilute. The Hamiltonian of the system is diagonalized by canonical transformation; this has the effect of separating the energy into 2 parts, (a) the ground state energy and (b) that which corresponds to an ideal Bose gas composed of "elementary excitations" or quasi-particles. This formalism was applied to the calculation of the pair distribution function of the system. The quantity was calculated by averaging over a grand canonical ensemble constructed with the total number of quasi-particles. The obtained result is valid both for the condensed and gaseous phases of the system and also for any distance r between the particles. A discussion of this result and the one obtained by the binary collision expansion method is presented, and a comparison between these 2 results and experimental results at 4.2°K is given. (Contractor's abstract, modified)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NATURE OF THE SINGULARITIES IN THE SPECTRUM OF A ONE-DIMENSIONAL IONIC LATTICE, by J. Gillis and G. [H.] Weiss. Sept. 1959, 4p. (Technical note no. BN-184) (AFOSR-TN-59-931) (AF 18(600)-1315) AD 226854; PB 144312 Unclassified

Also published in Phys. Rev., v. 115: 1520-1521, Sept. 15, 1959.

It is known, by a theorem of van Hove, that regular lattices will have singularities in their frequency spectra, the type of singularity depending on the dimension. Although several studies of the 1-dimensional lattice with Coulomb interactions have appeared, no one yet has succeeded in identifying the type of singularity that appears in addition to the inverse square root-singularity, in the frequency spectrum. In this note it is established that for a 1-dimensional crystal the singularity is of the form $g(\omega) \sim A[(\omega - \omega_1)^{-1/2} \ln 1/(\omega - \omega_1)^{-1/2}]$ where A is a constant and ω_1 is the position of the singularity. (Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

DISPERSION RELATIONS AND VIBRATIONAL FRE-

QUENCY SPECTRA, by A. A. Maradudin and G. H. Weiss. Oct. 1959, 9p. (Technical note no. BN-187) (AFOSR-TN-59-110-1) (AF 18(600)1315) AD 228739; PB 144782 Unclassified

Also published in Nuovo Cimento, Series X, v. 15: 408-415, Feb. 1, 1960.

Many relations have been given connecting the dispersion relation and frequency spectrum for a vibrating lattice. It is the purpose of this paper to show that these relations can all be derived from a single integral representation by using different representations of the delta function. (Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRONIC GROUND STATE OF AN APERIODIC ONE-DIMENSIONAL DELTA-FUNCTION LATTICE, by A. A. Maradudin and B. S. Gourary. Nov. 1959, 4p. incl. diagr. (Technical note no. BN-189) (AFOSR-TN-59-1131) (In cooperation with Johns Hopkins U., Silver Spring, Md.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1315 and Bureau of Ordnance under NOrd-7386) AD 229963; PB 145314 Unclassified

The study of impurity band conductivity leads to the problem of the electrical conductivity of 1-dimensional disordered lattices. The nature of solutions is considered of the following Schroedinger equation:

$$\left[-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} + V(x) \right] \psi(x) = E \psi(x), \text{ where } V(x) \text{ is an}$$

aperiodic potential energy, and the equation is written in Hartree atomic units. (Contractor's abstract)

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Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

WEAK AND ELECTROMAGNETIC INTERACTIONS, by A. Salam and J. C. Ward. [1959] [10]p. [AF 18(600)-1315] Unclassified

Published in Nuovo Cimento, Series X, v. 11: 568-577, Feb. 18, 1959.

The postulate of a local connection in a charge space leads to the introduction of 3 spin fields. One of these can be identified with the electromagnetic, and the other 2 can be shown to mediate all known weak interactions, thus unifying these interactions with electromagnetism. The theory takes account of the fact that weak interactions violate parity and strangeness conservation while electromagnetic interactions do not do so. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

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Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ANHARMONIC LATTICE VIBRATION ABSORPTION IN A ONE-DIMENSIONAL DIATOMIC LATTICE (Abstract), by A. A. Maradudin and R. F. Wallis. [1959] [1]p. [AF 18(600)1315] **Unclassified**

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 143, Mar. 30, 1959.

Using the Born-Huang theory of optical absorption in anharmonic lattices, calculations have been made of the optical absorption coefficient of a 1-dimensional diatomic lattice with nearest neighbor interactions for which the potential energy has been expanded up to cubic terms in the atomic displacements. For this model it is possible to obtain exact expressions in closed form for the absorption coefficient in both the low- and high-temperature limits. The frequency dependent damping constants in this theory vary as the cube of the absolute temperature at high temperatures in contrast with the linear dependence obtained from the classical treatments of Blackman and Neuberger.

962

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

QUANTUM STATISTICAL PAIR DISTRIBUTION FUNCTION (Abstract), by S. Fujita, A. Ishihara, and E. W. Montrolli. [1959] [1]p. [AF 18(600)1315] **Unclassified**

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 14, Jan. 28, 1959.

Using the idea of "torons" introduced by Montroll and Ward, it is shown that the pair distribution function in the grand canonical ensemble is expressed in terms of propagators corresponding to the normal and exchange scattering of 2 "torons" in position-temperature space. The "toron" is a mathematical entity which circulates around the positron-temperature torus and in terms of which the quantum-statistical effect is conveniently expressed. Since the momentum representation of the propagators of torons is found to take the same expression for the classical and quantum statistical cases, there exists a simple transformation which enables us to write down the quantum statistical counterpart from the Boltzmann statistical propagators. Assuming small coupling constants, the diagrams representative of "toron" scattering are analyzed by using the same

methods in quantum field theory. Explicit calculations are made for the pair distribution function of an electron gas at low and high temperatures.

963

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ABSORPTION AND EMISSION SPECTRA OF AN ELECTRON IN A ONE-DIMENSIONAL DEEP TRAP, by B. S. Gourary and A. A. Maradudin. [1959] [17]p. incl. diags. (In cooperation with Johns Hopkins U., Silver Spring, Md.) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1315] and Bureau of Ordnance under NORD-7386) **Unclassified**

Abstract published in Proc. 1959 Internat'l. Symposium on Color Centers in Alkali Halides, Oregon State Coll., Corvallis (Sept. 8-11, 1959) [Salem] Oregon State Board of Higher Education, 1959, p. 20.

Also published in Jour. Phys. Chem. Solids, v. 13: 88-104, May 1960.

The wave functions and the energies of the bound states of an electron in a special 1-dimensional deep trap are calculated. Only 2 essential approximations are made in the course of the treatment, namely the Born-Oppenheimer approximation for the separation of the electronic and the nuclear motions, and the harmonic approximation for the lattice energy. Further approximations are also made, but these are not essential to the calculation and they can be avoided, if necessary. Green's function techniques are employed in the solution of the electronic and the lattice-vibration problems, and they make possible the treatment of both the localized and the extended lattice-vibration modes and their influence on the electronic absorption (emission) spectrum. The first 2 moments of the absorption and emission spectra are then calculated. The principal utility of this work lies in providing a test case for more approximate theories, although a generalization of the method to 3 dimensions and to more realistic potentials should also be possible. (Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

VIBRATION FREQUENCY SPECTRA OF DISORDERED LATTICES. II. SPECTRA OF DISORDERED ONE-DIMENSIONAL LATTICES, by C. Domb, A. A. Maradudin and others. [1959] [13]p. incl. diags. refs. [AF 18(600)1315] **Unclassified**

Published in Phys. Rev., v. 115: 24-36, July 1, 1959.

By using a combination of the moment-trace method and a new method, the "delta-function" method, the vibrational frequency spectrum of a randomly disordered,

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2-component, isotopic, linear chain has been computed for a wide range of the concentrations of the 2 kinds of particles and of their mass ratios. In addition the particular case of a chain in which the mass of 1 of the isotopic constituents becomes infinite can be treated exactly, and the results of this analysis shed light on the form of the spectra for lattices with large but finite mass ratios for the 2 constituents. The spectra are characterized by the disappearance of the square-root singularity at the maximum frequency which is found in ordered 1-dimensional lattices, and by the appearance of impurity bands, the nature of which is discussed. Finally, the zero-point energy of a randomly disordered lattice is calculated and compared with the zero-point energy of an ordered lattice and of the separated phases. (Contractor's abstract)

965

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE TRANSMISSION OF ELECTROMAGNETIC WAVES IN THE PRESENCE OF A CONDUCTING LAYER OF GAS, by G. S. S. Ludford. Feb. 1959, 22p. (Technical note no. BN-160) (AFOSR-TN-59-159) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)154 and Office of Ordnance Research under DA 36-034-ORD-1486) AD 211118; PB 139852
Unclassified

Two related questions concerning the transmission of electromagnetic waves are considered: (1) The reflection and transmission of plane waves at a perfectly conducting layer of gas in an otherwise non-conducting atmosphere, when there is a uniform external magnetic field perpendicular to the layer present. The result is that a layer of finite depth h is an almost perfect filter, being transparent to waves of frequency $(n\pi A_0)/h$ (A_0 = Alfvén velocity, n an integer). (2) The existence of plane surface waves for such a finite layer. There is always one such wave and, for certain ranges of frequency, two. The first becomes choked at the filter frequencies; its velocity first tending to zero and then jumping to a finite value. The second chokes at the frequencies $(n\pi A_0 a_0)/h$, $a_0^2 = A_0^2 + a_0^2$ (a_0 = acoustic velocity). (Contractor's abstract)

966

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE FLOW OF A CONDUCTING FLUID PAST A MAGNETIZED SPHERE, by G. S. S. Ludford and J. D. Murray. Apr. 1959 [20]p. incl. diagr. (Technical note no. BN-169) (AFOSR-TN-59-424) (In cooperation with Harvard U., Cambridge, Mass.) (Sponsored jointly by

Air Force Office of Scientific Research under AF 49-(638)154 and Office of Ordnance Research under DA 36-034-ORD-1486) AD 214774; PB 140802
Unclassified

Also published in Jour. Fluid Mech., v. 7: 516-528, Apr. 1960.

In the steady flow of an incompressible, inviscid, conducting fluid past a magnetized sphere, the 1st-order effects of the magnetic field and conductivity are studied. Paraboloidal wakes of vorticity and magnetic intensity are formed, the former being half the size of the latter. The vorticity, generated by the non-conservative electromagnetic force, is logarithmically infinite on the sphere. For the case of a dipole at the center of the

sphere, the drag coefficient is $C_D = \frac{144\mu'^2}{5(2\mu + \mu')^2} \beta R_M$,

where μ and μ' are the permeabilities of the fluid and sphere, respectively, β is the ratio of the smallest magnetic pressure at the sphere to the free-stream dynamic pressure, and R_M is the magnetic Reynolds number.

(Contractor's abstract)

967

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

FURTHER RESULTS ON THE FLOW OF A CONDUCTING FLUID PAST A MAGNETIZED SPHERE, by G. S. S. Ludford and J. D. Murray. June 1959, 9p. (Technical note no. BN-174) (AFOSR-TN-59-648) (In cooperation with Harvard U., Cambridge, Mass.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)154 and Office of Ordnance Research under DA 36-034-ORD-1486) AD 218328; PB 142274
Unclassified

Also published in Proc. Sixth Midwestern Conf. on Fluid Mech., Texas U., Austin (Sept. 1959), Austin, Texas U. Press [1959] p. 457-465.

In this paper the general axially symmetric magnetic distribution is considered in more detail than in the previous report (item no. 966). In particular, the drag for an off-center dipole is determined. (Contractor's abstract)

968

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

THE PROPAGATION OF SMALL DISTURBANCES IN HYDROMAGNETICS, by G. S. S. Ludford. [1959] [14]p. incl. diagr. (AF 49(638)154)
Unclassified

Published in Jour. Fluid Mech., v. 5: 387-400, Apr. 1959.

AIR FORCE SCIENTIFIC RESEARCH

This paper is concerned with the propagation of small initial disturbances in a conducting gas under the influence of a uniform external magnetic field. For a perfect conductor, there are 3 types of plane waves, each of which depends strongly on the angle at which the magnetic field is crossed. The modifying effects of finite conductivity are determined and, in the case of these waves, this is done uniformly for all angles. A general disturbance may be resolved into 2 parts, 1 of which satisfies a 4th-order equation and the other a 5th; for a perfect conductor these reduce to 2nd- and 4th-order equations, respectively. The free oscillations of the gas are examined when it is contained in a rectangular box, and, in particular, when the external field is very weak or very strong. For vanishingly weak fields the idealization of infinite conductivity proves to be inadequate. Finally, the initial-value problem is discussed. (Contractor's abstract)

969

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

THE PROPAGATION OF WAVES ALONG AND THROUGH A CONDUCTING LAYER OF GAS, by G. S. S. Ludford. [1959] [14p. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)-154 and Office of Ordnance Research under DA-36-034-ORD-1485) AD 261590 Unclassified

Published in Jour. Fluid Mech., v. 9: 119-132, Sept. 1960.

Two related questions concerning the transmission of electromagnetic waves are considered. (1) The reflection and transmission of plane waves at a perfectly conducting layer of gas in an otherwise nonconducting atmosphere, when there is a uniform external magnetic field perpendicular to the layer is discussed. Here the main result is that a layer of finite depth h is an almost perfect filter, being transparent to waves of frequency $n\pi A_0/h$ (A_0 = Alfvén velocity, n an integer).

(2) The existence of plane surface waves for such a finite layer is also examined. There is always 1 such wave and, for certain ranges of frequency, 2. The 1st becomes 'choked' at the filter frequencies, its velocity 1st tending to zero and then jumping to a finite value.

The 2nd chokes at the frequencies $n\pi A_0 a_0/h$ ($a_0^2 = A_0^2$) (a_0 = acoustic velocity). (Contractor's abstract)

970

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON A MEAN VALUE THEOREM, AND ITS CONVERSE, FOR THE DISPLACEMENTS IN THE THEORY OF

ELASTICITY, by J. B. Diaz and L. E. Pryne. Jan. 1959, 7p. (Technical note no. BN-161) (AFOSR-TN-59-212) (AF 49(638)228) AD 211666 Unclassified

The displacement components in the theory of elasticity obey a certain mean value theorem which is the analogue of Gauss' mean value theorem in potential theory. This mean value theorem, and its converse, are proved directly, using only the corresponding theorem of Gauss, and its converse, in potential theory. (Contractor's abstract)

971

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

EXACT BOUNDS FOR SOLUTIONS OF HYPERBOLIC EQUATIONS BY FINITE DIFFERENCE METHODS, by H. F. Weinberger. Mar. 1959, 13p. (Technical note no. BN-165) (AFOSR-TN-59-372) (AF 49(638)228) AD 213858; PB 142533 Unclassified

The mean square deviation of the finite difference approximation from the solution of the wave equation vanishing on the surface of an N-cube and satisfying given Cauchy data is bound in terms of the Cauchy data. The bound is proportional to the mesh parameter h . (Contractor's abstract)

972

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

HYPERBOLIC AND PARABOLIC EQUATIONS WITH SUBHARMONIC DATA, by A. Weinstein. Mar. 1959, 14p. incl. refs. (Technical note no. BN-164) (AFOSR-TN-59-426) (AF 49(638)228) AD 214776

Unclassified

Published in Proc. Symposium on Numerical Treatment of Partial Differential Equations with Real Characteristics, Rome (Italy) (Jan. 28-30, 1959) Rome, Libreria Eredi Virgilio Veschi, 1959, p. 74-86.

Monotonicity and convexity properties are studied for a class of hyperbolic and parabolic equations with subharmonic data. Previous results on the case of non-subharmonic data are extended. (Contractor's abstract)

973

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

UNIQUENESS THEOREMS FOR THE DIFFERENTIAL EQUATION $u_{xy} = f(x, y, u, u_x, u_y)$, by W. [L.] Walter. Feb. 1959, 26p. incl. refs. (Technical note no. BN-159) (AFOSR-TN-59-577) (AF 49(638)228) AD 217024; PB 142680 Unclassified

AIR FORCE SCIENTIFIC RESEARCH

The question of uniqueness of the characteristic boundary value problem is discussed for the hyperbolic differential equation $u_{xy} = f(x, y, u, u_x, u_y)$. A number of well known uniqueness theorems for the ordinary differential equation $y' = f(x, y)$ (among them the theorems of Nagumo and Osgood) are shown to be valid for the hyperbolic equation. (Contractor's abstract)

974

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON THE EXISTENCE THEOREM OF CARATHÉODORY FOR ORDINARY AND HYPERBOLIC EQUATIONS, by W. [L.] Walter. June 1959, 38p. incl. refs. (Technical note no. BN-172) (AFOSR-TN-59-614) (AF 49(638)228) AD 217401 Unclassified

The existence theorem of Peano for the ordinary differential equation $y' = f(x, y)$ was generalized by Carathéodory to functions $f(x, y)$ with singularities of a certain type. It is shown that a generalization of the same kind can be performed with the hyperbolic differential equation $u_{xy} = f(x, y, u, u_x, u_y)$. An existence and uniqueness theory for the characteristic and for the non-characteristic initial value problem of the equation in the sense of Carathéodory is given. (Contractor's abstract)

975

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

EXACT INFORMATION BY FINITE DIFFERENCE APPROXIMATION, by H. F. Weinberger. June 1959, 12p. incl. refs. (Technical note no. BN-173) (AFOSR-TN-59-644) (AF 49(638)228) AD 218327; PB 142689 Unclassified

Presented at Sixth annual High-Speed Computer Conf., Louisiana State U., Baton Rouge, 1959.

Exact bounds are obtained for the stresses and the torsional rigidity in the classical torsion problem from the solution of a corresponding finite difference problem. (Contractor's abstract)

976

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

BOUNDS IN THE CAUCHY PROBLEM FOR THE LAPLACE EQUATION, by L. E. Payne. [1959] [11]p. incl. refs. (AFOSR-TN-59-645) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)228] and National Science Foundation) Unclassified

Also published in Arch. Rational Mech. and Anal., v. 5: 35-45, 1960.

Let u be a solution of Laplace equation $\Delta u = 0$ in a bounded n -dimensional domain D and let Σ be a portion of D . If $|u| \leq M$ in D , then for any $P \in D$, $|u(P)|^2 \leq K_0 M^{2(1-\delta)} [K_1 \int_{\Sigma} u^2 d\sigma + K_2 \int_{\Sigma} |\text{grad } u|^2 d\sigma]^{\delta}$, where the K_i are constants depending only on Σ , D , and δ is a function of Σ , D , P , $0 < \delta < 1$. The significance of this inequality is that it establishes the continuous dependence, in the uniform sense, of solutions of $\Delta u = 0$, on the Cauchy data of u on Σ , these data being considered in the $L^2(\Sigma)$ norm. Inequalities of a similar nature, but with $\int_{\Sigma} u^2 d\sigma$, $\int_{\Sigma} |\text{grad } u|^2 d\sigma$ replaced by $\sup_{\Sigma} u^2$, $\sup_{\Sigma} |\text{grad } u|^2$, have been derived by M. M. Laurentiev (Izves. Akad. Nauk SSSR. Ser. Mat., v. 20: 819-342, 1956; Dokl. Akad. Nauk SSSR, v. 112: 195-197, 1957. (Math Rev. Abstract)

977

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON SOME GENERALIZED CAUCHY PROBLEMS AND THE CONVEXITY OF THEIR SOLUTIONS, by R. W. Carroll. Apr. 1959, 101p. incl. diagrs. (Technical note no. BN-168) (AFOSR-TN-59-649) (AF 49(638)228) AD 218561 Unclassified

A class of generalized Cauchy problems are treated for equations of the type of the Euler-Poisson-Darboux (EPD) equation. In the case of the EPD equation Weinstein's results about the convexity and growth of the solution are extended to the most general multiply subharmonic initial data and some of his criteria are sharpened. The conditions under which there will be a convexity theorem for equations of this type are examined. For the EPD equation of index $n-1$ a study is made when the generalized solution is a solution in the usual sense. (Contractor's abstract)

978

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON A SINGULAR DIFFERENTIAL OPERATOR, by A. Weinstein. July 1959, 11p. incl. refs. (Technical note no. BN-175) (AFOSR-TN-59-651) (AF 49(638)228) AD 218326; PB 142272 Unclassified

Some applications are given of a singular differential operator to some problems in differential equations.

The operator is of the form: $D_k(u) = \frac{d^2 u}{dt^2} + \frac{k}{t} \frac{du}{dt}$.

(Contractor's abstract)

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Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

UPPER AND LOWER BOUNDS FOR QUADRATIC INTEGRALS, AND AT A POINT, FOR SOLUTIONS OF LINEAR BOUNDARY VALUE PROBLEMS, by J. B. Diaz. June 1959, 47p. incl. refs. (Technical note no. BN-178) (AFOSR-TN-59-720) (AF 49(638)228) AD 219685; PB 149729 Unclassified

An introduction is presented to several methods for obtaining reliable, precise, numerically computable upper and lower bounds for a large class of problems of the general nature of those mentioned in the title. For definiteness, only certain specific boundary value problems are considered in detail, although the same procedures can be easily seen to be applicable in more general situations. (Contractor's abstract)

980

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

ON UNIQUENESS THEOREMS FOR ORDINARY DIFFERENTIAL EQUATIONS AND FOR PARTIAL DIFFERENTIAL EQUATIONS OF HYPERBOLIC TYPE, by J. B. Diaz and W. L. Walter. July 1959, 16p. (Technical note no. BN-177) (AFOSR-TN-59-740) (AF 49(638)228) AD 219684; PB 142989 Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 90-100, July 1960.

Uniqueness theorems for the ordinary differential equation $y' = f(x, y)$ and for the hyperbolic partial differential equation $u_{xy} = f(x, y, u, u_x, u_y)$ are proved by means of an elementary method, which is also applicable in more general situations, and involves only the ordinary Lagrange mean value theorem of the differential calculus and simple properties of continuous real valued functions. (Contractor's abstract)

981

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

A THEORY OF LOWER BOUNDS FOR EIGENVALUES, by H. F. Weinberger. Aug. 1959, 97p. incl. refs. (Technical note no. BN-183) (AFOSR-TN-59-974) (AF 49(638)228) AD 226855; PB 144306 Unclassified

A polynomial equation is derived whose roots are lower bounds for the eigenvalues of a differential operator. The coefficients of the equation depend upon some arbitrary functions and upon the minimal information necessary to determine any lower bounds. Conditions are given under which the lower bounds obtained converge

to the correct eigenvalues as more arbitrary functions are used. The method serves to unify and improve many of the known methods of finding lower bounds. (Contractor's abstract)

982

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

NEW INEQUALITIES FOR MEMBRANE AND PLATE EIGENVALUES, by L. E. Payne. Sept. 1959 [14]p. (Technical note no. BN-186) (AFOSR-TN-59-1040) (AF 49(638)228) AD 226856; PB 144292 Unclassified

Part I also published in Jour. Math. and Phys., v. 39: 155-159, July 1960. (Title varies)

Two notes are presented on isoperimetric inequalities for membrane and plate eigenvalues. Part I - A Note On Isoperimetric Inequalities for Plate Eigenvalues gives the upper and lower bounds for clamped plate eigenvalues in terms of fixed membrane eigenvalues for the same region. Part II - Some Applications of Krahn's Inequality, gives a natural extension of the isoperimetric inequality of Faber and Krahn. (Contractor's abstract)

983

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

[ON THE DIFFERENTIAL EQUATION $u_{xy} = f(x, y, u, u_x, u_y)$ I. SINGLE VALUE THEOREMS FOR THE CHARACTERISTIC INITIAL VALUE PROBLEMS] Über die Differentialgleichung $u_{xy} = f(x, y, u, u_x, u_y)$. I. Eindeutigkeitsätze für die charakteristische Anfangswertaufgabe, by W. [L.] Walter. [1959] [17]p. incl. refs. (AF 49(638)228) Unclassified

Published in Math. Zeitschr., v. 71: 308-324, 1959

This is the 1st of 3 parts that propose the study of an equation of the type $u_{xy} = f(x, y, u, u_x, u_y)$ with initial Cauchy conditions. Some already known theorems (Osgood, Nagumo, Kamke) are reviewed. Thus, the discussion on uniqueness theorem for the solution of $u_{xy} = f(x, y, u, u_x, u_y)$ independent of u_x is expanded. A generalization is given of a uniqueness criterion for differential systems of this type.

984

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

[ON THE DIFFERENTIAL EQUATION $u_{xy} = f(x, y, u, u_x, u_y)$.

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II. EXISTENCE PROPOSITIONS FOR THE INITIAL VALUE PROBLEMS] Über die Differentialgleichung $u_{xy} = f(x, y, u, u_x, u_y)$. II. Existenzsätze für das charakteristische Anfangswertproblem, by W. [L.] Walter. [1959] [18]p. (AF 49(638)228) Unclassified

Published in Math. Zeitschr., v 71: 436-453, 1959.

The problem in the title is continued to be treated by generalizing methods which apply to ordinary differential equations. Part I deals with uniqueness. Part II is largely concerned with existence. It is shown that a solution exists if f is continuous and bounded and satisfies the inequality $|f(x, y, u, v, w) - f(x, y, u, \bar{v}, \bar{w})| \leq g_1(y, |v - \bar{v}|) + g_2(x, |w - \bar{w}|)$, provided the continuous functions $g_1(x, z)$ are nondecreasing in z with $g_1(x, 0) = 0$ and the ordinary differential equations $z'(x) = g_1(x, z)$ have certain regularity properties. A direct relation of the equation $u_{xy} = h(x, y, u)$ with ordinary differential equation $w'(x) = h(x, y, w(x))$ is established. Namely, if the solution of the initial-value problem for the ordinary differential equation is not unique, the Goursat problem for the partial differential equations does not have a solution for arbitrary initial data. Finally, it is shown that under any of the conditions of uniqueness given in Part I, the Picard iteration converges to the solution of the Goursat problem if a solution exists.

985

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRIC SPARK METHOD FOR QUANTITATIVE MEASUREMENTS IN FLOWING GASES, by H. F. Bomelburg, J. Herzog, and J. R. Weske. Jan. 1959 [28]p. incl. illus. diagrs. table, refs. (Technical note no. BN-157) (AFOSR-TN-59-273) (AF 49(638)385) AD 212707; PB 140222 Unclassified

The operating principle of the technique and the required instrumentation are described. Characteristics of spark discharges are analyzed theoretically and experimentally. A calibration is established for quantitative evaluation of spark photographs. Examples of application are given for subsonic, transonic, and supersonic flow and for investigations of turbomachines. (Contractor's abstract)

986

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRIC SPARK METHOD FOR QUANTITATIVE MEASUREMENTS IN FLOWING GASES, by H. J. Bomelburg, J. Herzog, and J. R. Weske. [1959]

[8]p. incl. illus. diagrs. table, refs. (Technical note no. BN-157a) (AFOSR-TN-59-273a) (AF 49(638)385) AD 230363 Unclassified

Published in Zeitschr. Flugwissensch., v. 7: 322-329, 1959.

This report is an addendum to item no. 985 and enlarges somewhat on the data presented therein.

987

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

PLASMA DYNAMICS--FROM THE GAS DYNAMIC POINT OF VIEW, by S.-I. Pal. Dec. 1958, 21p. incl. refs. (Technical note no. BN-154) (AFOSR-TN-59-34) (AF 18-(600)993 and AF 49(638)401) AD 209206 Unclassified

Also published in Proc. First Internat'l. Symposium on Rarefied Gas Dynamics, Nice (France) [July 2-5, 1958] New York, Pergamon Press, 1960, p. 394-405.

The fundamental concepts of plasma dynamics, the dynamics of ionized media, and its relations with ordinary gas dynamics are discussed. First the plasma dynamics were considered from a microscopic point of view. The application of kinetic theory to plasma is briefly reviewed; particularly the extension of Maxwell-Boltzmann equations to the plasma flow and its limitations. Secondly, the plasma dynamics were considered from a macroscopic point of view. The conservation equations for plasma and its relations with the kinetic theory are given and discussed. Finally, the conservation equations were applied to a special case of fully ionized plasma to obtain all the important parameters which characterize the flow of plasma. A special case in which the general plasma equations may be reduced to ordinary magneto-gas dynamics equations is indicated. (Contractor's abstract)

988

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

RAYLEIGH'S PROBLEM IN A TRANSVERSE MAGNETIC FIELD, by H.-T. Yang. Dec. 1958 [12]p. incl. diagrs. refs. (Technical note no. BN-158) (AFOSR-TN-59-47) (AF 49(638)401) AD 209418; PB 145567 Unclassified

Rayleigh's problem of an infinite flat plate set impulsively into uniform motion in its own plane, in the presence of a transverse uniform magnetic field, is studied in the present note. The fluid is assumed to be an incompressible continuum, and the plate electrically non-conducting. Two limiting cases are discussed somewhat in detail. (1) The magnetic field is very weak. In this case it is found that the flow field is only

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slightly perturbed from the classical Rayleigh's result. (2) The magnetic field is very strong. Here the flow field is greatly influenced by the magnetic field. An Alfvén wave, propagating at high speed in the direction of the magnetic field, gives rise to a small discontinuity in the flow velocity at the wave front. (Contractor's abstract)

989

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE ELECTRIC CONDUCTIVITY OF A PARTIALLY IONIZED GAS, by A. C. Pipkin. Apr. 1959, 30p. incl. table. (Technical note no. BN-170) (AFOSR-TN-59-489) (AF 49(638)401) AD 215842; PB 142180

Unclassified

Also published in Phys. Fluids, v. 4: 154-158, Jan. 1961. (Title varies)

The electrical conductivity of a gas in a magnetic field may be calculated from transfer equations. The present calculation makes use of an approximation based on the smallness of the electron-ion mass ratio. A further approximation based on the smallness of neutral atom collision cross sections in comparison to Coulomb cross sections is possible when the temperature is not too high, but this approximation is used only after the general expression for the conductivity has been obtained. (Contractor's abstract)

990

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SELECTED TOPICS FROM THE THEORY OF GAS FLOW AT HIGH TEMPERATURES. VI. SOME ASPECTS OF PARTICLE INTERACTION IN GASES, by J. M. Burgers. June 1959, 40p. incl. refs. (Technical note no. BN-176) (AFOSR-TN-59-631) (AF 49(638)-401) AD 218782; PB 143012

Unclassified

Three examples are considered of particle interaction in gases, referring to (a) reactions taking place at close binary encounters; (b) collisions between charged particles treated with the aid of a 2-particle distribution function; and (c) electric fields which appear when there are differences in positive and negative charge density, as are found in the case of plasma oscillations. (Contractor's abstract)

991

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE WAVE MOTIONS OF SMALL AMPLITUDE IN RADIATION-ELECTRO-MAGNETO-GAS DYNAMICS,

by S. I. Pai and A. I. Speth. July 1959 [21]p. incl. diagrs. (Technical note no. BN-180) (AFOSR-TN-59-879) (AF 49(638)401) AD 225691; PB 143387

Unclassified

Also published in Proc. Sixth Midwestern Conf. on Fluid Mech., Texas U., Austin (Sept. 1959), Austin, Texas U. Press [1959] p. 446-456.

The fundamental equations of radiation-electro-magneto-gas dynamics are discussed. These equations are linearized under the condition that there exists an externally applied uniform magnetic field. Wave motions of infinitesimal amplitude which may be divided into a transverse wave and a longitudinal wave are analyzed. Radiation phenomena exert influence only on the longitudinal wave while the transverse wave is independent of the radiation field. The radiation effect is characterized by introducing a radiation parameter which is the ratio of radiation pressure to the gasdynamic pressure. For ideal plasma, it may be expressed in terms of an effective radiation sound speed. Various simple cases of this wave motion of small amplitude in radiation electro-magneto-gas dynamics are discussed. The condition where the radiation effect becomes important is also discussed. (Contractor's abstract)

992

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

THE WAVE MOTIONS OF SMALL AMPLITUDE IN A FULLY IONIZED PLASMA. PART I. WITHOUT EXTERNAL MAGNETIC FIELD, by S. I. Pai. Nov. 1959 [24]p. incl. diagrs. refs. (Technical note no. BN-191) (AFOSR-TN-59-1271) (AF 49(638)401) AD 229705; PB 144778

Unclassified

Also published in Rev. Modern Phys., v. 32: 882-887, Oct. 1960.

Wave motions of infinitesimal amplitude in a fully ionized plasma, consisting of singly charged ions and electrons, were investigated. A 2-fluid theory was used. There are no externally applied electromagnetic fields. First the linearized fundamental equations for both the ions and electrons in the plasma as well as those for the electromagnetic field were constructed. They were then applied to the case of a plane harmonic wave. It was found that the wave motion can be separated into 3 groups, characterizing 2 transverse waves (which are not distinguishable among themselves) and one longitudinal wave. Undamped transverse waves occur only when the frequency ω of the wave is higher than the plasma frequency of the electrons ω_e , and there are no such waves if $\omega < \omega_e$. For longitudinal waves, there is one undamped mode when (ω/ω_e) is smaller than unity. At low frequencies the speed of propagation of this mode is the sound speed of the plasma as a whole. The speed of propagation decreases as the frequency ω of the wave in-

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creases and tends to a limiting value equal to the sound speed of the ions of the plasma. This latter speed is $1/\sqrt{2}$ times the sound speed for the plasma as a whole. When (ω/ω_e) is greater than unity, a second undamped wave can occur. The speed of propagation of this wave is infinite when $\omega/\omega_e = 1$ and decreases toward the limiting value of the sound speed of the electrons as the frequency of the wave increases toward infinity. (Contractor's abstract)

993

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

SECOND APPROXIMATIONS FOR THE STRESS TENSOR AND THE HEAT FLUX IN A GAS, by H.-T. Yang. [1959] [2]p. [AF 49(638)401] Unclassified

Published in Phys. Fluids, v. 2: 237-238, Mar.-Apr. 1959.

Support is given to the simplified Bhatnagar-Gross-Krook transfer equation as a satisfactory approximation of the Boltzmann collision as far as the 2nd approximation. This support verifies the use of the simplified approach in the acquisition of qualitative information.

994

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ON THE LINEARIZATION OF BOLTZMANN'S EQUATION IN RELATION TO ADIABATIC AND ISOTHERMAL BEHAVIOR (Abstract), by J. M. Burgers. [1958] [1]p. [AF 49(638)401] Unclassified

Presented at meeting of the Amer. Phys. Soc., San Diego, Calif., Nov. 24-26, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 198, Mar. 30, 1959.

To linearize Boltzmann's equation the collision terms on the right-hand side are replaced by a simplified expression, and the distribution function for the velocities is split into an undisturbed part F_0 and a small disturbance (for convenience a single type of monatomic molecule is taken). As restoring term on the right-hand side a Maxwellian distribution is used, not $-F_0$, but with a number density, mean flow velocity, and mean temperature to be found from the condition that the conservation equations must be satisfied. Such linearized equations are applied to the behavior of a gas subjected to a periodic impressed force field. When the conservation conditions are worked out, a result is obtained which can be adapted to adiabatic or to isothermal behavior, depending on ratios formed out of the collision frequency

and wave number of the impressed force, and mean molecular speed. For an impressed electric field the relative change in number density is not always given by $\pm e\phi/kT$ (ϕ : potential).

995

Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park.

LAMINAR JET MIXING OF ELECTRICALLY CONDUCTING FLUID IN A TRANSVERSE MAGNETIC FIELD, by S. I. Pai. [1959] [2]p. (AF 49(638)401) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 254-255, Apr. 1959.

The effect on laminar jet mixing of an electrically conducting, incompressible, and viscous fluid under an applied transverse magnetic field is discussed. Only the case of small electrical conductivity σ or small magnetic Reynolds Number is considered so that the induced magnetic field may be neglected. The fundamental equation of the problem is given as $u(\partial u/\partial x) + v(\partial u/\partial y) = -(Q/9)x^{-2n}u + v(\partial^2 u/\partial y^2)$ ($\partial u/\partial x$) + $(\partial v/\partial y) = 0$ where the external magnetic field is taken as $H_0(x) = H_1 x^{-n}$ and $Q = 9(\sigma/\rho)\mu_e^2 H_1^2$; H_1 is a constant. The boundary conditions are also listed. It is shown that for the 1st approximations, if $f = f_0 + Q_1^{-m}f_1$, the increment of the axial velocity component u over the corresponding value in the ordinary fluid dynamics increases with Q . A similar solution is also made for $n = 2/3$, $m = 0$. Such a solution is called a similar solution because the shapes of velocity distribution u at various x -stations is similar.

996

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

ON THE MECHANISM OF THERMAL IONIZATION (Abstract), by H. D. Weymann. [1959] [1]p. [AF 49(638)401] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 284, Apr. 30, 1959.

A theory is given for the thermal ionization behind strong shock waves. It is shown that the process which essentially determines the time to reach a definite degree of ionization consists of a 2-step mechanism in which an atom is 1st excited to the resonance level by a collision with another atom and it becomes completely ionized in a successive collision with an atom assuming in both cases that sufficient translational energy is available. The theoretical results concerning the

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dependence of the ionization rate on time and temperature are in good agreement with the experimental results. A comparison of the theoretical and the experimental results further allows a determination of the excitation cross sections for atom-atom collisions. The diffusion of electrons out of an initially neutral plasma is considered and expressions are given for the stationary electron density and the resulting potential. Experimentally measured diffusion potentials agree well with the calculations.

997

Maryland U. [Inst. for Fluid Dynamics and Applied Mathematics] College Park.

MAGNETOGASDYNAMIC PROBLEMS FROM THE POINT OF VIEW OF PARTICLE DYNAMICS, by J. M. Burgers. [1959] [17]p. (AF 49(638)401)

Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 288-304. (AFOSR-TR-59-108)

Attention is directed, with the use of 2 examples, to the determination of the motion of a single particle, in order to indicate some of the problems that turn up when attempts are made to solve the equations of motion. It is pointed out that when the mean free path of the particles becomes long in comparison to other dimensions, the motion of the individual particle takes on added importance. Collisions between particles can be neglected, and the various particle motions become independent of each other. The role of "external electric fields" is investigated and its influence on particles carrying an electric charge discussed.

998

Maryland U. Inst. for Molecular Physics, College Park.

ELASTIC SCATTERING OF SLOW IONS IN GASES, by E. A. Mason and J. T. Vanderslice. Feb. 24, 1959 [29]p. incl. diagrs. tables, refs. (Rept. no. IMP-OSR-12) (AFOSR-TN-59-185) (AF 18(600)1562) AD 211325; PB 139853

Unclassified

Also published in Jour. Chem. Phys., v. 31: 594-600, Sept. 1959.

Differential cross sections for the elastic scattering of slow ions by neutral atoms or molecules have been calculated by numerical integration of the classical equations of motion. The model used for the ion-neutral potential energy function consists of 3 terms: an r^{-4} attraction, an r^{-6} attraction, and an r^{-12} repulsion. The attractive terms are theoretically sound, but the repulsive term is empirical. Quantum effects have been ignored, but an approximate formula indi-

cates at what point the classical calculations begin to fail in any low energy region where experimentation is difficult. (Contractor's abstract)

999

Maryland U. Inst. of Molecular Physics, College Park.

THE KIRKENDALL EFFECT IN GASEOUS DIFFUSION, by K. P. McCarty and E. A. Mason. Sept. 11, 1959 [86]p. incl. diagrs. tables, refs. (Rept. no. IMP-OSR-13) (AFOSR-TN-59-966) (AF 18(600)1562) AD 226853; PB 143917

Unclassified

Also published in Phys. Fluids, v. 3: 908-922, Nov.-Dec. 1960.

The different rates of transfer by random motion of the 2 gases in binary diffusion tends to build up a hydrostatic pressure in 1 region of the mixture. This pressure will cause a back flow of the 2 gases together. The analogous effect in solids, the Kirkendall effect, was demonstrated experimentally for gases, and the results are explained theoretically. The apparatus used to observe the Kirkendall effect in gases was essentially 2 bulbs connected by a capillary tube and a larger diameter tube. A drop of silicone oil blocked the larger tube. Diffusion of gases through the capillary tube built up a pressure difference that caused the drop to move. The motion of the drop was predicted from the results of kinetic theory. The motion of the drop was used to determine the diffusion coefficients for several gas systems after the system He-Ar was used to calibrate the apparatus. The accuracy of these diffusion coefficients is comparable with the accuracy of those obtained by other methods.

1000

Maryland U. Inst. of Molecular Physics, College Park.

INVESTIGATIONS OF INTERMOLECULAR FORCES, by E. A. Mason. Final rept. Sep. 15, 1955 - Sept. 15, 1959. Oct. 15, 1959, 32p. incl. diagr. table, refs. (AFOSR-TR-59-147) (AF 18(600)1562) AD 228141; PB 144347

Unclassified

A new phenomenon in gaseous diffusion was investigated which is the analogue of the Kirkendall effect in solids. The results were shown to be explainable on the basis of the rigorous kinetic theory of gases. The experimental method appears to be a novel and useful way of measuring gaseous diffusion coefficients. Investigations of molecule-molecule and ion-molecule forces were also carried out theoretically through studies of scattering and mobility. Applications of the results included determination of gaseous ion mobilities and of high-temperature gas properties. (Contractor's abstract)

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1001

[Massachusetts General Hospital. Neurophysiological Lab., Boston]

STUDIES OF EVOKED RESPONSES BY FLASH IN MAN AND CAT, by M. A. B. Brazier. [1958] [26]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)98, National Institute of Neurological Diseases and Blindness, and Office of Naval Research) Unclassified

Published in Proc. Henry Ford Hospital Internat'l. Symposium on Reticular Formation of the Brain, Detroit, Mich. (Mar. 14-16, 1957), Boston, 1958, p. 151-176.

Studies of the secondary discharge evoked by a brief supramaximal light flash under control conditions and under a variety of anesthetics, e.g., avertia, chloralose, chloroform and nembutal, indicate that the secondary discharge does not have a diffuse representation at the cortex and has no counterpart in the lateral geniculate. Amplitude of response at the collicular and more rostral dorsal levels of the brain stem is not as drastically affected by barbiturate or avertin anesthesia as those in the medial brain stem. The presence of double responses in the center median and subthalamus suggests that impulses from a single flash reach these centers by more than 1 route although the possibility of corticofugal return as well as optic nerve input is recognized. The double response at the cortex under anesthesia has the appearance of blocking a normally active inhibitory mechanism.

1002

Massachusetts General Hospital. [Neurophysiological Lab.] Boston.

EFFECT OF DI-ETHYL ETHER ANESTHESIA ON THYROID FUNCTION OF RATS: PITUITARY, ADRENAL AND THYROID RELATIONSHIP, by T. Oyama, M. S. Potsaid, and D. W. Slingerland. [1959] [6]p. incl. diagrs. tables, refs. (AF 49(638)98) Unclassified

Published in Endocrinol., v. 65: 459-464, Sept. 1959.

The possible role of the pituitary and adrenal hormones in the depressive effect of ether anesthesia on thyroid function in rats was studied. Di-ethyl ether anesthesia for 2 hr significantly depressed release of radioiodine (I^{131}) from the thiouracil blocked thyroid gland in both bilateral adrenalectomized rats maintained with cortisone and in the bilateral adrenal-medullectomized rats. Administration of ether anesthesia depressed thyroidal uptake of radioiodine in the hypophysectomized rats treated with small doses of exogenous TSH, although no significant effect was noted in the absence of thyrotropin. Ether anesthesia inhibited the TSH-stimulated release of thyroidal I^{131} in the hypophysectomized rats. Recovery from this inhibition by

ether was rapid and more marked when larger amounts of TSH were used. These findings indicate that the effect of di-ethyl ether anesthesia in rat thyroid was not mediated through the adrenal cortex or medulla. It is suggested that the ether anesthesia might influence thyroid function in rats by inhibiting the action of TSH or by a direct action on the thyroid.

1003

[Massachusetts Inst. of Tech., Cambridge]

ON THE INEQUALITY OF CASTELNUOVO-SEVERI, by A. Mattuck and J. Tate. [1958] [5]p. (AFOSR-3571) [AF 18(603)91] Unclassified

Also published in Abhandlungen Math. Seminar Hamburg U., v. 22: 295-299, 1958.

The Castelnuovo-Severi inequality (1) $1/2 [D \cdot D] < dd'$ is related to the divisors D of a surface of the form $V = C \times C'$, the product of two complete, singularity-free curves C and C' , where $d = [D \cdot (P \times C')]$ and $d' = [D \cdot (C \times P)]$ this straight line from Dupon Cresp. C' . The authors show that the inequality can be derived from the Riemann-Roch theorem for V . The equation can be written, as a consequence of the particular structure of V as the product of two curves, in the form (2) $\chi(D) = 1/2[D \cdot D] - dd' + (d+1-g')(d'+1-g)$; g, g' are the forms of C resp. C' , and $\chi(D)$ signifies the Euler characteristic of D , therefore one has the alternating non-negative sum $\chi(D) = \dim D - \sup D + \dim (K-D)$ (K a canonical divisor on V). If $\phi_1, \phi_2: C' \rightarrow C$ are two rational mappings, and D_1, D_2 the associated graphs, one has from (1), used on the divisors of the form $n_1 D_1 + n_2 D_2$, the formula (3) $|\text{Grad } \phi_1 + \text{Grad } \phi_2 - N| \leq 2g(\text{Grad } \phi_1, \text{Grad } \phi_2)^{1/2}$, where $N = [D_1 \cdot D_2]$ signifies the number of solutions P^1 from $\phi_1(P^1) = \phi_2(P^1)$, counted with the multiplicities of algebraic geometry. Formula (3) contains as a special case the Riemann conjecture for a curve C upon a finite body k with q elements: one selects $C' = C$, ϕ_1 as the identity mapping, ϕ_2 as that mapping which gives all coordinates the power of q .

1004

Massachusetts Inst. of Tech., Cambridge.

AN INTERPRETATION OF G. WHITEHEAD'S GENERALIZATION OF H. HOPF'S INVARIANT, by M. A. Kervaire. [1959] [21]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)91 and National Science Foundation) Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Published in Ann. Math., v. 69: 345-365, Mar. 1959.

In the present paper, the generalized H. Hopf's invariant $H: \pi_{d+n+1}(S_{n+1}) \rightarrow \pi_{d+n+1}(S_{2n+1})$, due to G. Whitehead, is given a new definition which has some similarity with the original H. Hopf's definition. The invariant $H(f)$ appears as depending in particular on the position in S_{d+n+1} of the inverse images M_d, M'_d by $f: S_{d+n+1} \rightarrow S_{n+1}$ of 2 regular values q, q' in S_{n+1} . As an application of the new definition of H , it is proved that any regular imbedding (without self-intersection) of the d -sphere into euclidean $(d+n)$ -space induces over S_d the trivial normal bundle provided that $2n > d+1$.

1005

Massachusetts Inst. of Tech., Cambridge.

THE IRREDUCIBILITY OF THE REGULAR SERIES ON AN ALGEBRAIC VARIETY, by A. Mattuck. [1959] [5]p. [AF 18(603)91] Unclassified

Published in Illinois Jour. Math., v. 3: 145-149, Mar. 1959.

Let V be a projective algebraic variety over an algebraically closed field k , A the Albanese variety of V , and $f: V \rightarrow A$ the canonical map of V into A , which (replacing, if necessary, V by the birationally equivalent graph of f on $V \times A$) may be supposed single-valued. Let $V(n)$ be the n -fold symmetric product of V with itself, and $F: V(n) \rightarrow A$ the map defined by $F(x_1 + x_2 + \dots + x_n) = \sum f(x_i)$, the addition on the right referring to the group law on A . The inverse images $F^{-1}(a)$ of points on A represent regular series in the sense of Albanese (Ann. Scuola Norm. Sup. Pisa, v. 3: 1-26, 1934). Proof is presented of the following theorem. Let $\dim V = r > 1$, let $q = \dim A$, and let $g(\cong q)$ be the genus of a generic curve on a normal model of V . Then: (1) when $n \geq g$ the generic $F^{-1}(a)$ is absolutely irreducible and F is surjective; and (2) if n_0 is the smallest integer for which (1) holds then, if $n \geq n_0 + q$, every $F^{-1}(a)$ is absolutely irreducible and of dimension $nr - q$. (Math. Rev. abstract)

1006

Massachusetts Inst. of Tech., Cambridge.

A THEOREM ON AFFINE CONNEXIONS, by M. Hicks. [1959] [13]p. [AF 18(603)91] Unclassified

Published in Illinois Jour. Math., v. 3: 242-254, June 1959.

The object of this study is to generalize a theorem of W. Ambrose to the non-Riemannian case. The outline

of proof is the same as that of the theorem of Ambrose, except for modifications. The theorem characterizes a simply connected C^∞ manifold, on which is defined a complete affine connection, by the behavior of the curvature and torsion forms under parallel translation along finitely broken geodesics emanating from some fixed point. In the analytic case, one need only consider unbroken geodesics. As an immediate consequence of the result, the (known) theorem is obtained which states that a simply connected manifold, on which is defined a complete connection having zero curvature and torsion invariant under parallel translation, is a Lie group. Relaxing the simply connected hypothesis to just connected, and adding an assumption that the holonomy group be the identity, proof can be presented to show that the manifold is a homogeneous space. An example shows that there is no hope of proving that M is a Lie group under these hypotheses.

1007

[Massachusetts Inst. of Tech., Cambridge]

THE GEOMETRIC INTERPRETATION OF A SPECIAL CONNECTION, by I. M. Singer. [1959] [6]p. (AF 18-603)91 Unclassified

Published in Pacific Jour. Math., v. 9: 585-590, 1959.

An esthetic problem remaining in the foundations of Riemannian geometry is discussed. To each Riemannian metric on a manifold one associates a connection on its bundle of bases. This connection is uniquely characterized by its having zero torsion and its parallel translation preserving the metric. By the very definition, at each tangent space of the bundle the connection assigns a complement to the vertical. Yet the various existence proofs of the Riemannian connection are computational and do not exhibit this complementary space (the horizontal space) directly. The problem is how can one do so directly from the metric, given by the reduction of the bundle to the bundle of frames. Under rather special circumstances, a geometric and coordinate free construction of a connection is exhibited. This includes the class of complex analytic bundles and gives a geometric construction of a connection of type (1,0) with curvature of type (1,1), useful in algebraic geometry. For the case of complex vector bundles Nakano computes this connection in terms of coordinates. For Kähler manifolds it turns out that this connection is the Riemannian connection restricted to the unitary subbundle. Hence a solution is obtained to the aforementioned problem for Kähler manifolds.

1008

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

INELASTIC DIFFUSION IN PANELS, by M. M. Chen.

AIR FORCE SCIENTIFIC RESEARCH

Nov. 1958, 9p. incl. diagrs. (ASRL-TR-76-1)
(AFOSR-TN-59-33) (AF 49(638)160) AD 209205;
PB 140041 Unclassified

The problem of inelastic diffusion in stiffened panels has been studied. The governing ordinary differential equation has been solved numerically for the case where the Ramberg-Osgood exponent, n , is equal to 20. For the case of $n = 2$ the solution is in a closed form. Numerical results have been carried out for several loading levels and for several geometrical parameters. (Contractor's abstract)

1009

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

ON LARGE DEFLECTION OF CURVED STRIPS UNDER COMBINED THERMAL AND PRESSURE LOADINGS, by M. M. Chen. May 1959, 52p. incl. diagrs. tables, refs. (ASRL-TR-76-2) (AFOSR-TN-59-676) (AF 49(638)160) AD 219871 Unclassified

The governing equations in various forms for large deflections of initially curved strips, including thermal force and thermal moment effects, are derived based on Reissner's variational principle. Exact solutions are obtained for the cases corresponding to net tensile, compressive, and zero in-plane forces with arbitrary distributed, thermal loads, and small initial curvature. Numerical examples are given for a clamped-clamped strip with a particular initial shape, temperature distribution, and uniform pressure. For the purpose of comparison, approximate solutions based on Reissner's variational principle and minimum potential energy are obtained. In both methods, the vibrational modes and assumed modes are used. Good agreement is shown in the numerical examples. These approximate methods of solution will be used for the case of finite plates. (Contractor's abstract)

1010

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

STRESS FUNCTIONS FOR PLATES BOUNDED BY PIECEWISE ANALYTIC CURVES, by M. M. Chen and P. T. Hsu. [1959] 4p. [AF 49(638)160] Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 240, Mar. 1960.

In a recent note Balmer (Jour. Aero/Space Sci., v. 26: 675-676, Oct. 1959) has shown that the stress function for a plate of polygonal shape fulfilling the stress free boundary conditions can be derived from the generalization of the standard expression for the Airy stress function

for rectangular plates. The application of this generalization to include planforms bounded by piecewise analytic curves is examined.

1011

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

ON SOME SOLUTIONS FOR LARGE DEFLECTIONS OF HEATED STRIPS AND PLATES, by M. M. Chen and K. A. Foss. [1959] [30]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)160 and Wright Air Development Center under AF 33(616)5504) Unclassified

Also published in Proc. Fourth Midwestern Conf. on Solid Mech., Texas U., Austin (Sept. 9-11, 1959), Austin, Texas U. Press, 1959, p. 207-22.

The governing equations for large deflections of initially curved plates and strips, including thermal force and thermal moment effects, are derived. Exact solutions are obtained for uniform curved strips under arbitrary lateral loads and thermal loads. Numerical examples are given for a strip under uniform pressure with a given temperature distribution. For comparison, approximate solutions based on Reissner's variational principle and on the minimum potential energy principle have been computed. In both methods, thermal buckling modes, vibrational modes, and other assumed modes were used. Good agreement is shown in the numerical examples for heated strips. Analogous approximate solutions for finite plates are formulated and discussed. (Contractor's abstract)

1012

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

VIBRATION AND FLUTTER OF CYLINDRICAL AND CONICAL SHELLS, by Y. Shulman. June 1959, 174p. incl. diagrs. tables, refs. (ASRL-TR-74-2) (AFOSR-TN-59-776) (AF 49(638)219) AD 226444; PB 144307 Unclassified

The theory of thin shells is examined, and some simplified general expressions are presented. An appropriate variational principle is formulated, and the similarity to shallow-shell theory is shown. These results and those of the more exact Flugge shell theory are applied to the problem of free vibration of conical shells. The general problem of panel and shell flutter is reviewed, and a physical explanation of the phenomenon is offered, based on conclusions drawn from piston theory results. A general formulation is given, followed by a method of solution which is named here after Movchan and Houboit, who apparently developed it independently. The Galerkin method is examined, and its characteristics for this

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problem are discussed. This method is then applied to the solution of the flutter problem of cylindrical and conical shells. (Contractor's abstract in part)

1013

Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge.

ON THE AEROELASTIC CHARACTERISTICS OF LOW ASPECT RATIO WINGS WITH CHORDWISE DEFORMATION, by J. Dugundji and J. D. C. Crisp. July 1959, 1v. incl. diagrs. tables, refs. (ASRL-TN-74-3) (AFOSR-TN-59-787) (AF 49(638)219) AD 227221; PB 143960
Unclassified

An investigation was made into the nature of chordwise flutter and divergence characteristics of low aspect ratio wings. Two simple low aspect ratio configurations were examined in detail. The 1st was a cantilever rectangular wing possessing a bending, a torsion, and a 1st chordwise bending mode. The 2nd was a free-free delta wing of sufficiently low aspect ratio so that spanwise deformations can be neglected. Some effects of aerodynamic heating and longitudinal accelerations on these planforms were also examined. Simple closed form solutions were developed for the flutter and divergence characteristics wherever appropriate. The general trends revealed may prove to be of interest to persons involved in the interpretation of aeroelastic analysis of such surfaces. Among the trends indicated was the role played by mass density ratio for the delta wings. At the lower mass density ratios, more chordwise modes had to be included in the modal type analyses. For high mass density ratios, the flutter characteristics became dependent on dynamic pressure q and independent of the mass density ratio.

1014

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

CORRECTION OF EPOCH ERROR IN CIRCULAR ORBITS. PART I. CORRECTION BY TANGENTIAL TRANSFER, by L. J. Berman. Feb. 5, 1959, 10p. incl. diagrs. table. (AFOSR-TN-59-62, pt. 1) (AF 49(638)-363) AD 209494; PB 140450
Unclassified

The correction is considered of the epoch parameter which locates a body in space at any given time. The size, shape, and orientation of the orbit are assumed to be correct; the original orbit is assumed to be circular; and the error is assumed to be variable from zero to a complete circuit, or period, in magnitude. The epoch correction is made by putting the vehicle into a transfer orbit with a period differing from that of the circle and then going back to the original orbit at some subsequent point of intersection. The orbit changes are effected by impulses of thrust. The case of the transfer orbit being tangential to the circle is discussed, i.e., when the thrust impulses are parallel

to the line of flight. The equations are all written in non-dimensional terms, each quantity being ratioed to the corresponding quantity for some standard orbit. (ASTIA abstract)

1015

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

CORRECTION OF EPOCH ERROR IN CIRCULAR ORBITS. PART II. CORRECTION BY NON-TANGENTIAL TRANSFER, by L. J. Berman. Apr. 30, 1959, 36p. incl. diagrs. (AFOSR-TN-59-62, pt. 2) (AF 49(638)363) AD 214637; PB 142191
Unclassified

A vehicle in a circular orbit is transferred into a second orbit by impulsive thrust. At some subsequent intersection of the 2 orbits, a second impulse is applied to transfer it back to the original orbit. In general, the average angular velocity in the transfer orbit will differ from that in the circular orbit, and the epoch of the body will be changed by such a maneuver. This maneuver is studied with a goal of determining what conditions affect the choice of the transfer orbit. In particular the time taken for completion of the epoch change and the characteristic velocity required are studied. Finally it is shown that the imposition of a restriction on the minimum perigee radius considerably modifies the choice and even makes some conditions impossible to satisfy. (Contractor's abstract)

1016

Massachusetts Inst. of Tech. Dept. of Aeronautics and Astronautics, Cambridge.

OPTIMUM EXHAUST VELOCITY FOR LOW-THRUST ESCAPE, by L. J. Berman. Sept. 1, 1959, 13p. incl. diagrs. (AFOSR-TN-59-929) (AF 49(638)363) AD 228262
Unclassified

A study was made to find the optimum value of exhaust velocity for escape orbits of vehicles with power-scaled propulsion systems. Since any interplanetary flight will be composed of segments of escape orbits and segments of Keplerian orbits, the results are generally applicable. The effect was shown of low accelerations on the optimum choice of exhaust velocity for power-scaled propulsion systems, and the effect on the actual performance of the vehicle was demonstrated. It is indicated that for the case of earth escape for moderate accelerations, accuracy in the determination of the exhaust velocity is not a critical factor. (Contractor's abstract)

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Massachusetts Inst. of Tech. Dept. of Mathematics,
Cambridge.

LORENTZ STRUCTURES ON THE PLANE, by J. W. Smith. [1959] 26p. (AFOSR-TN-59-652) (AF 49(638)-42) AD 228329; PB 144059 Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 226-237, May 1960.

Lorentz structures on the plane are investigated. After noting the most basic global properties of these spaces, a normal space is defined, and shown to be geodesically connected. The question arises then what can prevent a space from being normal, and the answer is found in certain structures which will be referred to as barriers. After introducing a notion of completeness, a connection is established between barriers and curvature for a complete space. Some examples are considered. (Contractor's abstract)

1018

Massachusetts Inst. of Tech. [Dept. of Mathematics]
Cambridge.

BEST POSSIBLE TRIANGLE INEQUALITIES FOR STATISTICAL METRIC SPACES, by E. Thorp. [1959] 12p. (AFOSR-TN-59-1159) (AF 49(638)42) AD 234730 Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 734-740, Oct. 1960.

The following problem is solved: Given a t-function, there exists a corresponding statistical metric space that can be made into a Menger space for which the t-function is strongest. The solution is had by constructing, for the given t-function, a space such that it is strongest. The space constructed has an uncountable number of points. For some t-functions, spaces may be constructed with a finite number of points. This is illustrated by an example, and an alternate construction is introduced. The construction for the general case is effected by associating a constraining triangle with each point in the domain of the real-valued function T. The alternate construction uses a single triangle to constrain T along a curve or throughout a region. An example of Menger space for which there is no strongest t-function is also given.

1019

[Massachusetts Inst. of Tech. Dept. of Mathematics,
Cambridge.]

AN OPERATOR THEORETIC APPROACH TO GENERALIZED FOURIER TRANSFORMS, by R. A. Kunze. [1959] [14]p. (AFOSR-65-0084) (AF 49(638)42) Unclassified

Published in Ann. Math., v. 69: 1-14, Jan. 1959.

Let G be a locally compact abelian group and let f be a measurable function on G. The operator Lf on $L_2(G)$ is defined as the operator whose domain consists of all g in $L_2(G)$ such that $\int |f(x-y)g(y)|dy$ is locally integrable and $\int f(x-y)g(y)dy$ is in $L_2(G)$ as functions of x, and whose value at g is the latter function. If Lf is densely defined and has a closure Lf , then Lf is unitarily equivalent via the Plancherel transform to multiplication by a measurable function F on the character group of G. The author calls F the generalized Fourier transform of f, and proceeds to explore this notion. In some ways this notion is well behaved; for example, anything in $L_p(G)$ for $1 \leq p \leq 2$ has the appropriate generalized Fourier transform, and so does the Heaviside function on the line. On the other hand, this notion is strange in some ways; for example it is not one-to-one (the generalized Fourier transform of any polynomial on the line is 0), and the author does not believe that the set of functions having a generalized Fourier transform is linear. (Math. Rev. abstract)

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Massachusetts Inst. of Tech. Dept. of Mathematics,
Cambridge.

LOCALIZATION AND SUMMABILITY OF MULTIPLE FOURIER SERIES, by E. M. Stein. [1958] [55]p. incl. refs. (AFOSR-65-0085) (AF 49(638)42) Unclassified

Published in Acta Math., v. 100: 93-147, 1958.

The theory of "spherical" summability of multiple Fourier series is dealt with by forming the Fourier series of f(x) so that $f(x) =$

$$\sum a_n e^{in \cdot} = \sum a_{n_1, n_2, \dots, n_k} e^{i(n_1 x_1 + \dots + n_k x_k)} \text{ where } n =$$

(n_1, \dots, n_k) is a vector with integral components. The general problem of the theory concerns itself with the validity (and meaning) of $\lim_{R \rightarrow \infty} S_R^\delta(x, f) = f(x)$ for some

appropriate δ . Results are presented for $L^p(Q_k)$, $1 < p \leq 2$ and for "near" $L^1(Q_k)$. For the former, assuming that $f(x) \in L^p(Q_k)$, $1 < p \leq 2$, then (1) if $f(x)$ vanishes in a neighborhood of x_0 , then $\lim_{R \rightarrow \infty} S_R^\delta(x_0, f) = 0$ ($\delta > 1/2(k-1)$). (2) If $S_R^\delta(x, f) = \sup_{R \rightarrow 0} |S_R^\delta(x, f)|$, then S_R^δ

$(x, f) \leq A_p \delta^{-1/p} \|f\|_p$, if $\delta > \alpha(2/p-1)$. (3) If $\delta > \alpha(2/p-1)$, then $\lim_{R \rightarrow \infty} S_R^\delta(x, f) = f(x)$ for almost every x. (4) If $\delta > \alpha(2/p-1)$, then $\lim_{R \rightarrow \infty} S_R^\delta(x, f) = 0$. (5) If $\delta > \alpha$

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$(2/p-1)-1/p'$, then $\lim_{R \rightarrow \infty} \frac{1}{R} \int_0^R |S_u^j(x, f) - f(x)|^2 du = 0$ for almost every x . For results "near" $L^1(Q_K)$, as always $\alpha = 1/2(k-1)$ (1) if $f(x)$ vanishes in a neighborhood of x_0 , and $\int_Q |f(x)| \log^+ |f(x)| dx$ is finite, then $\lim_{R \rightarrow \infty} S_R^\alpha(x_0, f) = 0$. (2) $\int_{Q_K} S_R^\alpha(x, f) dx < A \int_{Q_K} |f(x)| (\log^+ |f(x)|)^2 dx + B$. (3) If $\int_{Q_K} |f(x)| (\log^+ |f(x)|)^2 dx$ is finite, then $\lim_{R \rightarrow \infty} S_R^\alpha(x, f) = f(x)$ for almost every x . (4) If $\int_{Q_K} |f(x)| \log^+ |f(x)| dx < \infty$, then $\lim_{R \rightarrow \infty} \int_{Q_K} |S_R^\alpha(x, f) - f(x)| dx = 0$. (5) If $f(x) \in L^1(Q_K)$, then $\lim_{R \rightarrow \infty} \frac{1}{R} \int_0^R |S_u^\alpha(x, f) - f(x)|^2 du = 0$.

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Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

ELASTIC-PLASTIC TORSION OF A CIRCUMFERENTIALLY NOTCHED BAR, by J. B. Walsh and A. C. Mackenzie. [1959] [23]p. incl. diagrs. refs. (AFOSR-TN-59-710) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)957 and Office of Naval Research under N5ori-60) AD 225303; PB 143677 Unclassified

Also published in Jour. Mech. and Phys. Solids, v. 7: 247-257, Oct. 1959.

In this investigation of the torsion of the circumferentially notched bar of elastic-plastic material, methods have been outlined for obtaining: (a) a theoretical torque-twist curve, (b) plastic strains in the plane of the notch. Results of applying these methods are presented for a bar of particular geometry and extended to bars of other geometry. The discrepancy between the theoretical results and those obtained in an experimental study is a reflection of the difference between the ideal, non work-hardening material assumed in the theory and the work-hardening material available for experiment. (Contractor's abstract, modified)

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Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

CONTRIBUTION OF INTERFACE COUPLES TO THE ENERGY OF A DISLOCATION, by F. A. McClintock. [1959] 3p. (AFOSR-TN-59-711) (AF 18(600)957) AD 225302 Unclassified

Also published in Acta Metall., v. 8: 127, Feb. 1960.

An estimate of the magnitude of the effects of interface couples on dislocations may be obtained from the energy contributed by them if the displacements are those

usually found around a screw dislocation. Taking the x_1 and x_2 axes normal and the x_3 axis parallel to the screw dislocation having a Burgers vector b , the only displacement is that in the x_3 direction, u_3 , where $u_3 = (b/2\pi) \tan^{-1}(x_1/x_2)$. From this assumed displacement, the components of lattice rotation and then lattice curvature can be found. Equations were studied to determine a strain energy density in terms of the radius from the center of the dislocation.

1023

Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

ON NOTCH SENSITIVITY, by F. A. McClintock. May 9, 1959 [32]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-712) (AF 18(600)957) AD 225304; PB 143676 Unclassified

Also published in Welding Jour., v. 40: 202s-209s, May 1961.

A discussion of the need for considering the ductility of structures leads to the definition of both load and deformation factors relating the actual behavior of notched sections to that predicted by plasticity theory for fully ductile materials. Experiments on pure aluminum are in agreement with the fully plastic theory. Experiments on 7075 aluminum alloy and 4140 steel show a notch sensitivity, with a crack behavior and size effect similar to that predicted from elastic-plastic analysis. (Contractor's abstract)

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Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

THE SINGLY-GROOVED, PLANE STRAIN TENSILE TEST, by F. A. McClintock. [1959] [25]p. incl. illus. diagrs. table, refs. (AFOSR-TN-59-713) (AF 18(600)957) AD 225301; PB 143675 Unclassified

The distributions of stress and strain around a single groove in a plane strain specimen subject to fully plastic tension are found theoretically. The distinguishing features of this configuration are the lack of triaxiality and the constant strain pattern as the specimen separates. Experiments show a similar deformation, but quantitative agreement seems to require consideration of strain hardening and possibly anisotropy. The transition temperature is lower than in the Charpy test, and a shear lip is absent. (Contractor's abstract)

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Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

HEAT TRANSFER IN DISSOCIATED COMBUSTION GASES, by J. C. Cutting, J. A. Fay and others. July 1959 [45]p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-78) (AF 49(638)375) AD 220754; PB 143150
Unclassified

An outline is presented of a series of experiments and theoretical calculations performed to determine the rate of heat transfer from gases in detonation waves. For the experimental measurements, a wire heat transfer gage was developed and calibrated, and was used in conjunction with a regular shock tube through which the detonations were passed. Tests were performed using stoichiometric H_2-O_2 mixtures at various initial pressures, and also a number of $C_2H_2-O_2$ mixtures at an initial pressure of 1 atm. In both these series of tests, additional experiments were run to evaluate the effect on the heat transfer of coating the gage with iodine. A theoretical treatment of the heat transfer rates, based on stagnation point heat transfer theory, is presented as well as a detailed examination of the thermodynamic and transport processes taking place at the surface of the gage. The heat transfer to the coated gages is explained in terms of a non-catalytic wall effect. The total heat transfer is less than expected for the Mach and Reynolds' numbers of the experiments. (Contractor's abstract)

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Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

PRELIMINARY RESULTS OF MEASUREMENT OF EFFECTS OF DIFFUSION OF HELIUM INTO THE LAMINAR BOUNDARY LAYER OF A SUPERSONIC FLOW OF AIR IN A TUBE AT MACH 5, by S. W. Gouse, Jr., G. A. Brown, and J. Kaye. [1959] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)442] and Office of Naval Research) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 533-535, Aug. 1959.

The experiments were carried out in a continuously operating, axially symmetric wind tunnel. The length of the overall test section was 41 diam, comprising a porous test section, approx 7.2 diam, whose leading edge was approx. 1.8 diam from the nozzle exit plane, and 4 nylon sections of 8 diam each. A total of 15 runs were made, 5 without injection and 10 with helium injection. The overall behavior of the apparatus, with and without injection, was excellent in terms of the design specifications, as was the control of independent variables during operation of the tunnel. From the results it was concluded that the presence of a diffusion field of

helium in a laminar boundary layer of supersonic flow of air had no effect, within 1% on the average recovery factor over the injection region as long as the basic flow pattern is not disturbed. The results compare well with those of other investigators to the effect that the injection of helium leads to a slight increase in the recovery factor.

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Massachusetts Inst. of Tech. Dept. of Mechanical Engineering, Cambridge.

ANALYSIS OF EFFECTS OF DIFFUSION OF A FOREIGN GAS INTO THE LAMINAR BOUNDARY LAYER OF A SUPERSONIC FLOW OF AIR IN A TUBE, by J. R. Radbill and J. Kaye. [1959] [2]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)442] and Office of Naval Research) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 602-603, Sept. 1959.

A brief summary is presented of analytical studies of the diffusion of a foreign gas by means of uniform injection into the laminar boundary layer of a supersonic flow of air, with known and controllable boundary conditions. The basic equations were derived by means of kinetic theory, statistical mechanics, and the thermodynamics of irreversible processes and were then expanded into cylindrical coordinates and subjected to an order-of-magnitude analysis to yield boundary layer equations.

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Massachusetts Inst. of Tech. [Dept. of Physics] Cambridge.

THE USE OF POLARIZED NEUTRONS IN DETERMINING THE MAGNETIC SCATTERING BY IRON AND NICKEL, by R. Nathans, C. G. Shull and others. Nov. 19, 1958, 1v. incl. diagrs. table, refs. (Technical rept. no. 3) (AFOSR-TN-59-61) (In cooperation with Brookhaven National Lab., Upton, N. Y.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)84, Atomic Energy Commission, and National Security Agency) AD 209324; PB 142541
Unclassified

Also published in Jour. Phys. Chem. Solids, v. 10: 138-146, July 1959.

The polarized neutron beam technique is discussed and utilized in determining the magnetic scattering by iron and nickel. Procedures for obtaining and using polarized beams of monochromatic neutrons are outlined, and experimental data are presented on the performance of two polarizing crystals, Fe_3O_4 and $92Co-8 Fe$ alloy. The reflectivity of neutrons of different polarization state by single crystals of iron and nickel was

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studied and used for determining the magnetic scattering amplitudes at different scattering angles. Comparison is then made between the observed magnetic form values and theoretical values derived from calculated 3d wave functions. (Contractor's abstract)

1029

Massachusetts Inst. of Tech. [Dept. of Physics]
Cambridge.

RECENT MAGNETIC STRUCTURE STUDIES BY NEUTRON DIFFRACTION, by C. G. Shull. [1959] [6]p. incl. diags. table. [AF 18(603)84] Unclassified

Presented at Internat'l. Colloq. on Magnetism, Grenoble (France), July 2-6, 1958.

Published in Jour. Phys. et Radium, v. 20: 169-174, Feb.-Mar. 1959.

A review is presented of several magnetic structure studies performed recently by neutron diffraction methods. These include a study of the low temperature transition in Fe_3O_4 by Hamilton and experiments by

Roth on the magnetic structure ambiguities of the transition element monoxides. Recent studies using polarized neutron beam techniques are described and data presented on the ferromagnetic scattering by iron and nickel. (Contractor's abstract)

1030

Massachusetts Inst. of Tech. [Dept. of Physics]
Cambridge.

STATISTICAL THERMODYNAMICS, XIV, by L. Tisza. [1959] [3]p. (AFOSR-TN-59-601) (AF 49(638)95) AD 264337 Unclassified

Application is made of the thermodynamic theory of chemical reaction to nuclear chemistry. It is pointed out that, with reactions involving the transformations of elementary particles both criteria of molecular reactions including conservation of mass and validity of a structure formula break down. It is stated that structure formulas can be established only within the range of reactions consisting of the rearrangement of nucleons. The suggestion is made that the dynamic character of the reactions equations can be extended to irreversible processes such as reaction kinetics.

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[Massachusetts Inst. of Tech. Dept. of Physics,
Cambridge].

STATISTICAL THERMODYNAMICS, XI. A. THE THERMODYNAMIC THEORY OF LINE SINGULARITIES IN ONE-COMPONENT SYSTEM. B. DISTRIBUTION

FUNCTIONS IN STATISTICAL THERMODYNAMICS, by L. Tisza and P. M. Quay. [1959] [4]p. (AFOSR-TN-59-1248) (AF 49(638)95) Unclassified

A scheme is presented for the analysis and correlation of the experimental data concerned with the λ -anomalies in 1-component systems. By assuming that the Gibbs function can be represented as $G(p, T) = f(p) + h(T - T_\lambda)$

where $f(p)$ is a slowly varying function representing the Gibbs function along the λ -line, and $h(t)$ is a singular function with the properties that $h(0) = J$, $h'(0) = \text{finite}$, $h''(0) = -\infty$, it is shown that the significant thermodynamic function can be obtained. Entropy, volume, specific heat, expansion coefficient and the isothermal compressibility equations are all derived. It is indicated that this approach should be verified by its use on experimental data. Certain questions left open in the author's thesis are solved, and the material revised for future publication.

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Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

REVIEW OF UNSTEADY AERODYNAMIC STUDIES IN THE FLUID DYNAMICS RESEARCH GROUP, 1955-1958, by H. Kerner and H. Ashley. Dec. 1958 [57]p. incl. diags. tables, refs. (MIT Fluid Dynamics Research Group rept. no. 58-5) (AFOSR-TR-59-6) (AF 18(600)-961) AD 212285; PB 140000 Unclassified

A review is presented of theoretical research on unsteady aerodynamics. The configurations investigated at transonic, supersonic, and hypersonic speeds were wings, bodies, and wing body combinations. An iterative technique is used in transonic and supersonic flows to estimate aerodynamic loads on slender symmetrical configurations performing small lateral oscillations. Strip theory is applied to analyze wings with subsonic leading edges and supersonic trailing edges. For thin wings at high M the perturbation velocity potential is expanded in a series of M^{-2} . Only first and second-order terms in the perturbation velocities are considered. Oscillating hypersonic airfoils are analyzed by modified piston theories. The changes in the variables of state and flow direction are approximately taken into account for moderately strong shock waves. For strong shock waves which produce dissociation, the modified piston relation was derived by considering a simple wave in a dissociated flow in chemical equilibrium. A theory for estimating unsteady loads in the nose region of blunt-nosed bodies in hypersonic flow is described. It is based on small perturbations on an approximate steady flow field.

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Massachusetts Inst. of Tech. [Fluid Dynamics Research Group] Cambridge.

FORCES AND MOMENTS ON OSCILLATING WING-BODY COMBINATIONS AT SUPERSONIC SPEED, by H. Kennet and H. Ashley. [1959] [2]p. incl. diagrs. (AF 18(600)961) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 605-606, Sept. 1959.

The lift and moment due to small translational and pitching oscillations are determined. The development follows the original scheme of Adams and Sears and its application in the transonic case by Landahl. Graphs give the theoretical fixed axis damping in pitch at supersonic speed for slender midwing-body combinations, with various wing planforms, and various diam-wing-span ratios, and a comparison between theoretical and experimental values of static stability and fixed-axis damping in pitch.

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Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

TWO-DIMENSIONAL TRANSONIC UNSTEADY FLOW WITH SHOCK-WAVES, by W. Eckhaus. May 1959, 79p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 59-3) (AFOSR-TN-59-491) (AF 49(638)160) AD 215844 Unclassified

A study is made of the unsteady flow around an airfoil at transonic Mach numbers. For the unsteady part of the flow, small perturbations technique is employed and the interaction with the shock wave is considered. The case of an oscillating aileron is studied, and a solution is derived for the pressure distribution on the aileron. It is found that the solution has a simple form when the shock-wave is well ahead of the hinge-axis of the aileron. As the shock approaches the hinge-axis a correction must be added to the solution. An interpretation of these results is given. The results are compared with results of a theory which neglects the presence of the shock and it is found that both agree for $M = 1$. For $M \neq 1$, however, neglecting the presence of the shock waves introduces errors of the order of magnitude $(1 - M)^{1/2}$, where M is the local Mach number behind the shock. (Contractor's abstract)

1035

Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

ON THE STABILITY OF LAMINAR FLAME-FRONTS,

by W. Eckhaus. May 1959, 94p. incl. diagrs. tables. (MIT Fluid Dynamics Research Group rept. no. 59-4) (AFOSR-TN-59-562) (AF 49(638)160) AD 216757 Unclassified

A study is made of the stability of a plane laminar flame-front. The effects of the disturbances on the internal flame structure are investigated in detail, using small perturbations technique, and including the mechanism of diffusion, heat conduction and unsteady combustion. A formula for the non-steady flame propagation velocity is derived, on the assumption that flame thickness is small compared to the wavelength of the disturbances. The flame velocity is shown to depend on the curvature of the flame and on the perturbations of fluid velocities on the flame-boundary. The expression for the flame velocity contains coefficients which depend on the physical properties of the mixture that is being burned. Using these results in stability analysis, it follows that the properties of the mixture, as expressed in terms of coefficient of heat-conductivity and various coefficients of diffusion, actually determine the stability picture. For some estimated values of these parameters, the theoretical results are shown to agree with the general trend of the experimentally observed behavior. (Contractor's abstract)

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Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

ESTIMATION OF UNSTEADY AIRLOADS ON BLUNT BODIES IN A HYPERSONIC STREAM. PART I. THEORY, by H. Kennet. Oct. 1959, 42p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 59-6) (AFOSR-TN-59-1273) (AF 49(638)160) AD 232606; PB 146335 Unclassified

A theoretical method is developed for estimating aerodynamic loads on symmetric blunt-nosed bodies, at zero angle of attack, performing small-amplitude harmonic oscillations in a main hypersonic stream. Time dependent effects are introduced as small perturbations superimposed on an approximate steady field. A power series solution yields the perturbation pressure distribution on the body. Shock amplitude and phase angle are also obtained. The results are applied to a spherical cap, in which case the leading terms of the series solution are evaluated. (Contractor's abstract)

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Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

UNSTEADY BOUNDARY LAYERS: A SURVEY OF THE LITERATURE, by R. E. Kelly. Sept. 1, 1959, 59p. incl. refs. [AF 49(638)160] Unclassified

The existing literature on the role of the boundary layer

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in studies of dynamic, aeroelastic phenomena is reviewed. The report is divided into 2 parts. The 1st approach involves an attempt to solve directly the unsteady viscous flow equations. Discussion is made of basic, well-known solutions, attempts at linearization of the boundary-layer equations, the calculation of higher-order approximations, integral methods, unsteady stagnation-point flow, the inclusion of turbulence and the problem of the unsteady separation point. In the 2nd line of approach to the investigation of viscous effects in aeroelastic phenomena, certain knowledge of the unsteady boundary layer and its effect on pressure distribution is assumed, i.e., the position of the separation points, the displacement thickness, or various aerodynamic derivatives. Thus, the 2nd part is composed of investigations which assume certain knowledge of the boundary layer and base their results upon this knowledge.

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Massachusetts Inst. of Tech. Fluid Dynamics Research Group, Cambridge.

ON SOME PROBLEMS IN RADIATIVE HEAT TRANSFER, by S. S. Ahlborn. Apr. 1959, 205p. incl. diagrs. refs. (MIT Fluid Dynamics Research Group rept. no. 59-1) (AFOSR-TN-59-531) (AF 49(638)207) AD 216538 Unclassified

The time dependent and steady temperature distributions in radiating homogeneous solid conductors are considered. Solutions to the unsteady heat conduction equations were sought for the cases of a semi-infinite solid, a flat plate, a solid sphere and a spherical shell. The initial temperature is taken to be uniform. Radiation into vacuum takes place at the boundaries and follows the Stefan-Boltzmann law or a generalized form thereof. All cases show that the spatial temperature distribution can be deduced from the surface temperature through a Duhamel Integral. The surface temperature problem is then formulated as a singular, nonlinear Volterra integral equation, the kernel of which depends on the particular geometry of the body in question. The problems are considered of steady state temperature distribution and radiative heat transfer in high speed free molecule flow. The radiation boundary condition assumes grey body radiation according to the Stefan-Boltzmann law. The cases considered include the infinite geometries with zero and infinite, as well as finite, thermal conductivities. When the temperature is nondimensionalized appropriately, the problem is found to possess similitude properties. Solutions for this dimensionless temperature are found in terms of a similarity parameter. The expected range of the similarity parameter in the upper atmosphere for flight conditions and material properties, is discussed. (Contractor's abstract)

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Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

TEMPERATURE-DEPENDENT LAG IN POLYCRYSTALLINE YTTRIUM-IRON GARNET, by D. J. Epstein and B. Frackiewicz. Jan. 1959, 10p. incl. diagrs. (Technical rept. no. 135) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under Nonr-184110 and Rome Air Development Center under AF 49(635)2872) AD 209818 Unclassified

Presented at Fourth Conf. on Magnetism and Magnetic Materials, Philadelphia, Pa., Nov. 17-20, 1958.

Also published in Jour. Appl. Phys., Suppl., v. 30: 295S-296S, Apr. 1959.

Certain samples of polycrystalline yttrium-iron garnet are characterized by a room-temperature permeability spectrum having 2 regions of dispersion, 1 at microwave, the other at radio frequency. The former dispersion is identified as gyromagnetic in origin. The radio-frequency dispersion, which exhibits a temperature-activated shift to lower frequency with decreasing temperature, appears due to an electron-diffusion controlled domain-wall relaxation. The activation energy for the process is 0.38 ev. (Contractor's abstract)

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Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

PRINCIPLES OF MODERN MATERIALS RESEARCH, by A. von Hippel. Mar. 1959, 24p. incl. diagrs. table, refs. (Technical rept. no. 136) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-184110; Air Force under AF 30(635)2872 and Atomic Energy Commission under AT(30-1)1937) AD 214074 Unclassified

Published in Proc. Symposium on Materials Research in the Navy, Philadelphia, Pa. (Mar. 17-19, 1959), Dept. of the Navy, Washington, D. C., v. 2: 387-411, 1959.

The various aspects of modern materials research are presented and contrasted with classical materials research. It is pointed out that the former explores and designs on the molecular level. It starts with elementary building stones: the atoms and molecules composed of positive nuclei and compensating electron clouds, which react to electric and magnetic fields with electric and magnetic dipole moments; and the charge carriers, the ions and electrons, directed by such fields and influences by the structure and properties of their surroundings. An example is used to illustrate the method, and the advantages that the new method could offer to science are pointed out.

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Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

TEMPERATURE AND SPACE-CHARGE EFFECTS IN LIQUID HYDROCARBONS, by R. Coelho and M. Bono. June 1959, 13p. incl. illus. table, refs. (Technical rept. no. 137) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-184110] AD 219687

Unclassified

Preliminary results on the residual d-c conduction and space-charge polarization in n-hexane and n-heptane under highly inhomogeneous field conditions (thin wire in coaxial cylinder) are presented. A residual current is observed under high applied voltage for either polarity of the test cell. At 20°C the current is 1 order of magnitude larger when the wire is the positive electrode. As temperature is increased, the residual current for the wire positive decreases and for the wire negative increases, until at 50°C it is about the same for both polarities. By heating only the wire, observations supporting and extending these findings were made. The gross features of the current-voltage characteristics can be explained by dissociation of polar impurities in the region of high field strength. The dependence on polarity can be explained by space-charge distortion of the field. For negative wire, field emission appears to occur from the wire, surrounding it with a current-limiting space charge. (Contractor's abstract)

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Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

IONIC CONDUCTIVITY OF SILVER IODIDE PELLETS FOR SOLID-ELECTROLYTE BATTERIES, by J. N. Nirgudich. June 1959, 22p. incl. illus. tables. (Technical rept. no. 138) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-184110] AD 219686

Unclassified

Silver amalgam electrodes were found to provide polarization free contacts for the measurement of the ionic conductivity of compressed AgI powder pellets. Correlation of the conductivity data with x-ray diffraction studies established the presence of a deformed hexagonal phase as an important factor in determining pellet conductivity. Deformation can be induced by compression, but care must be taken to avoid transformation into the face-centered cubic phase with some resultant decrease in conductivity. Preliminary evidence is presented to the fact that hexagonal deformation can be induced by proper control of the AgI powder. (Contractor's abstract)

1043

Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

SATURATION OF THE MAGNETIC ABSORPTION IN DILUTE INHOMOGENEOUSLY BROADENED SYSTEMS, by J. S. Hyde. Oct. 1959, 18p. incl. diagr. refs. (Technical rept. no. 141) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-184110] AD 228364

Unclassified

Also published in Phys. Rev., v. 114: 1492-1495, Sept. 1, 1960

The existing theory due to Portis for the saturation of inhomogeneously broadened resonances is discussed and a new theoretical formulation of the problem is developed using an expression for the transition probability first given by Rabi. For γH_1 greater than both T_1^{-1} and T_2^{-1} , the rf field interacts with spins precessing in the frequency interval γH_1 ; this expression permits explicit calculation of the resulting magnetic loss. No assumption is made of the shape of the individual (homogeneously broadened) spin packets in weak exciting fields. For F centers in alkali halides, the results are identical with those of Portis, but the underlying physical reasons differ. (Contractor's abstract)

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Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

MAGNETIC RESONANCE AND RAPID PASSAGE IN IRRADIATED LiF, by J. S. Hyde. Oct. 1959, 29p. incl. diagrs. table, refs. (Technical rept. no. 142) [Bound with its Technical rept. no. 141, AD 228364] [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-184110] AD 228364

Unclassified

Also published in Phys. Rev., v. 119: 1463-1492, Sept. 1, 1960.

The experimental result of Portis that at room temperature the paramagnetic dispersion signal ($d\chi'_m/dH$) of radiation induced paramagnetic centers in LiF has the shape of an undifferentiated Gaussian curve and lags the modulation field by 90 degrees has been confirmed. His theory, explaining this result as a manifestation of rapid-passage behavior, has been tested over a range of experimental parameters and appears valid. In terms of this theory we found the spin-lattice relaxation time $T_1 = 1.5 \times 10^{-4}$ sec at room temperature. The prediction has been made by Portis that, if $\omega_m T_1 \gg 1$, where ω_m is the modulation frequency, the rapid-passage

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signal should lag the modulation field by 180 degrees. A lag of 130 degrees has been found at 4°K in LiF, using a modulation frequency of 23 cps, and the phase appears to approach a constant value. The same phase shift (130°) can be found at room temperature by using 400-cps modulation and can be interpreted as indicating that $T_1 = 2.6 \times 10^{-3}$ sec at 4°K. It seems more likely, however, that at 4°K the assumption made by Portis that $T_2 \gg T_1$ fails, and that spin-spin effects made the situation more complex. An argument is presented that the magnetic resonance arises from the F center. From its shape we have obtained a value for the hyperfine splitting: $h_\gamma = 32 \pm 1$ gauss. This result is compared with those of other workers who have reported resolved structure in LiF, and the conclusion is reached that the resolved structure resonances do not arise from the F center. (Contractor's abstract)

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Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge.

SOME OPTICAL PROPERTIES OF THE CUPROUS HALIDES AND RELATED COMPOUNDS, by R. Coelho. Oct. 1959, 34p. incl. illus. tables, refs. (Technical rept. no. 143) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-184110] AD 229194

Unclassified

The optical absorption spectra of evaporated films of cuprous chloride, bromide, and iodide have been investigated at various temperatures, in an attempt to find how the partial covalence of these compounds affects their optical excitation. Fundamental similarities of structure and shape between the spectra of the alkali and cuprous halides suggest that the localized excitation model is also valid in the latter case. However, noticeable differences in energy, intensity, and splitting indicate that the wave function of the excited electron spreads further away from the halogen nucleus than in the case of the alkali halides. This is supported by the observation of an inner photoeffect which seems to involve the diffusion of excitation. The position and shape of the absorption bands depend somewhat on the thickness of the films and on their state of annealing. Interesting observations on the influence of defects, crystal structure, and lattice distortion in CuCl, CuI, and CuBr, respectively, are reported. The absorption spectra of the cubic (sphalerite) and hexagonal (wurtzite) forms of CuI have been identified with the help of electron diffraction. In CuBr, a band splitting is observed at low temperature for films evaporated on a cleaved NaCl crystal and is attributed to a tetragonal distortion resulting from epitaxy with the substrate. All the observations can be explained qualitatively by regarding the excited state as a (p^5s) electronic configuration perturbed by the crystalline field of the lattice. (Contractor's abstract)

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Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

K-MESON-NUCLEON TOTAL CROSS SECTIONS FROM 0.6 TO 2.0 BEV, by H. C. Burrowes, D. O. Caldwell and others. [1959] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])

Unclassified

Published in Phys. Rev. Ltrs., v. 2: 117-119, Feb. 1, 1959.

An experiment to measure the K-nucleon total cross sections at high energy using the K-meson beam of the Bevatron is described. The cross sections for K^+-N , K^+-p , and K^--p were measured. The lifetimes of K^+ and K^- were determined. The K^+-p and K^+-n cross sections are about the same in this energy range, but the K^--p cross section is twice as large.

1047

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

PION-PROTON RESONANCE SCATTERING NEAR 900 MEV, by H. C. Burrowes, D. O. Caldwell and others. [1959] [3]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])

Unclassified

Published in Phys. Rev. Ltrs., v. 2: 119-121, Feb. 1, 1959.

The scattering of negative and positive pions by hydrogen in the laboratory energy range 470 to 1200 mev was investigated in order to clarify the broad resonance occurring near 900 mev. The target was five feet of liquid hydrogen. The experimental setup is described, and results given.

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Massachusetts Inst. of Tech. [Lab. for Nuclear Science] Cambridge.

$Ni^{60}(d,p)Ni^{61}$ STRIPPING ANALYSIS (Abstract), by R. A. Fisher and H. A. Enge. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 287, Apr. 30, 1959.

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The MIT-ONR Van de Graaff generator and the broad-range spectrograph have been used to study the angular distribution of protons emitted from a Ni^{60} target bombarded with the 7.5-mev deuterons. Some preliminary results of the stripping analysis of the most intense proton groups are given. The excitation energies of other Ni^{61} levels have been given by Paris in a previous report.

1049

Massachusetts Inst. of Tech. [Lab. for Nuclear Science]
Cambridge.

(p,p') AND (d,p) REACTIONS FROM SILVER (Abstract), by A. Sperduto, M. Mazari, and W. W. Buechner. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 287, Apr. 30, 1959.

Thin targets of natural silver and separated isotopes of silver 107 and 109 have been bombarded with protons and deuterons accelerated by the MIT-ONR Van de Graaff generator with energies up to 7.5 mev. The emitted proton groups have been analyzed with the broad-range magnetic spectrograph with observations being made at several angles between 20 and 130 degrees. Proton groups from inelastic scattering have been identified with levels in Ag^{107} at 0.328, 0.425, 0.784, and 0.984 mev and in Ag^{109} at 0.313, 0.416, 0.701, and 0.861 mev. Evidences for a weak inelastic group, corresponding to an excitation energy of about 100 kev, have been observed from both isotopes. Increased exposures are being planned to obtain more precise measurements. The measurements of several proton groups from the (d,p) reactions have been made. The Q value of the ground-state transition for the $\text{Ag}^{107}(\text{d,p})\text{Ag}^{108}$ reaction is 4.968 ± 0.010 mev and that for the $\text{Ag}^{109}(\text{d,p})\text{Ag}^{110}$ reaction is 4.585 ± 0.005 mev.

1050

Massachusetts Inst. of Tech. Lab. for Nuclear Science,
Cambridge.

ION FOCUSING PROPERTIES OF A QUADRUPOLE LENS PAIR, by H. A. Enge. [1959] [4]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2099) Unclassified

Also published in Rev. Scient. Instr., v. 30: 248-251, Apr. 1959.

The focusing properties of a quadrupole lens were studied, and the results of thick-lens calculations are presented in graphic form showing the field strength parameters and magnifications as functions of object. It is hoped that this paper will fill the need for results of calculations on focusing properties in a convenient form.

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Massachusetts Inst. of Tech. [Lab. for Nuclear Science]
Cambridge.

SINGLE QUANTUM ANNIHILATION OF POSITRONS (Abstract), by R. Weinstein. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 325, June 18, 1959.

The annihilation of positrons via single quantum emission has been experimentally investigated using a 3-mc Na^{22} source, a large collection efficiency (3.5%) poor resolution beta spectrometer, NaI(Tl) gamma- and x-ray detectors, 2 differential discriminators and a 10^{-7} sec coincidence circuit. The need for large nuclear recoil momenta requires that the annihilation takes place with a K-shell electron. A coincidence is required between a gamma ray and a K x-ray of the proper energies. Initial data on Pb, Pt, Ta, and Al targets is consistent with $\sigma \propto Z^n$, where $n = 5 \pm 3$. This rules out 2 quantum annihilation in the K shell, and agrees well with the expected Z^5 dependence. This salient feature of single quantum annihilation has not previously been observed. The counting rate decreased as expected for x-ray energies above and below the K x-ray peak. The absolute magnitude of the cross section was evaluated to $\pm 50\%$ at $E_\beta = 400$ kev. Within experimental accuracy the results agree with the Jager-Hulme cross section. The Born approximation cross section is clearly ruled out.

1052

Massachusetts Inst. of Tech. Lab. for Nuclear Science,
Cambridge.

SCATTERING OF 50- TO 140-MEV PHOTONS BY PROTONS AND DEUTERONS, by L. G. Hyman, R. [P.] Ely and others. [1959] [4]p. incl. diagrs. refs. (Sponsored

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jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098] Unclassified

Published in Phys. Rev. Ltrs., v. 3: 93-96, July 15, 1959.

A report is given on Compton scattering of photons by protons below π meson phototreshold. Experimental and theoretical cross sections for scattering of photons by hydrogen are plotted as a function of lab. energy at a center of mass angle of 90° . They are in good agreement with previous results. It is concluded that (1) the observed scattering of photons at 90° c.m. over the energy range 0-300 mev is described well by a model of the proton as a Dirac particle plus strong pion interactions giving the well-known $3/2$, $3/2^+$ and $1/2$, $3/2^-$ resonances, provided the half-life of the π -meson is greater than 10^{18} sec; and (2) the scattering of photons by deuterons below meson threshold is more than expected.

1053

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

ENERGY LEVELS OF A BOSE-EINSTEIN SYSTEM OF PARTICLES WITH ATTRACTIVE INTERACTIONS by K. Huang. [1959] [13]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev., v. 115: 765-777, Aug. 15, 1959.

An N-body Bose-Einstein system of particles with long-range attraction and hard-sphere repulsion between particles is considered. It is shown that if the constants of the interaction have values within a certain range it is possible to calculate the ground-state energy of the system as a function of Ω/N , where Ω is the volume of the box containing the system, in the limit $N \rightarrow \infty$, $\Omega \rightarrow \infty$, with $N/\Omega = \rho$ fixed. The results show that the system can possess an N-body bound state, which has an equilibrium density and negative energy, and that the interactions can be saturating. Excited states are also considered. It is shown that low-lying excitations consist purely of phonons, whose velocity agrees with that computed from the macroscopic compressibility, furnished by the ground state energy. The formula for the general excited energy levels suggests that thermodynamically the system has a "gas" phase and two "liquid" phases, the transition between the two "liquid" phases being the analog of the Bose-Einstein condensation of the ideal gas. Thermodynamic considerations are, however, not contained in this paper.

1054

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

RESULTS OF STRIPPING ANALYSIS OF THE REACTION $K^{39}(d,p)K^{40}$, by H. A. Enge, E. J. Irwin, Jr., and D. H. Weaner. [1959] [7]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098) Unclassified

Published in Phys. Rev., v. 115: 949-955, Aug. 15, 1959.

The MIT-ONR electrostatic generator and the broad-range spectrograph have been used to study the energies and angular distributions of protons emitted from a KI target bombarded with 6-mev deuterons. Excitation energies are given for 52 levels in K^{40} . Orbital angular momenta of captured neutrons in the stripping process are given for 38 of these excited levels and for the ground state. The reaction energy for the ground-state transition has been measured as $Q = 5.569 \pm 0.010$ mev. (Contractor's abstract)

1055

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

TWO BODY FORCES IN LIGHT DEFORMED NUCLEI, by D. M. Brink and A. K. Kerman. [1959] [13]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098) Unclassified

Published in Nuclear Phys., v. 12: 314-326, Aug. 1959.

There is evidence that the light nuclei in the aluminum region have rotational states. It is well known from studies of heavy rotating nuclei that an independent particle model for a deformed well as used by Nilsson is a surprisingly good approximation for many of the properties of these collective states. However, it has been clear for some time that 2 body correlations are important for a more complete understanding of the situation. Because of the number of single particle states for the light nuclei is relatively small and because isobaric spin is a good quantum number, some studies have been undertaken on the effect of 2 body forces on binding energies and energy levels. The method of Bacher and Goudsmit has been employed to find relations among binding energies which depend only upon the existence of 2 body forces and the assumption that the deformed wave function coupling scheme is a good first approximation. The relations so obtained are remarkably well fulfilled by the data while corresponding relations obtained for the spherical shell model are not. Some of the possible excited states in these nuclei are also discussed and estimates made of their energies.

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Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

PHOTOPRODUCTION OF NEUTRAL MESONS FROM HYDROGEN NEAR THRESHOLD, by P. D. Luckey, L. S. Osborne, and J. J. Russell. [1959] [3]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])

Unclassified

Published in Phys. Rev. Lett., v. 3: 240-242, Sept. 1, 1959.

The differential cross section for the reaction $\gamma + p \rightarrow p + \pi^0$ was measured for mean incident γ -ray energies of 170 and 190 mev by measuring single π^0 -decay γ -ray yields from a liquid hydrogen target at laboratory angles 48° , 81° , and 141° , and bremsstrahlung peak energies 160, 180, and 200 mev. The details of the absorption spectrometer are given. The spectrum of π^0 -decay γ rays in the center of mass of the reaction $\gamma + p \rightarrow p + \pi^0$ is given by an effective γ -ray production cross section

$$\frac{d^2\sigma}{d\Omega dE_\gamma} = \frac{2}{q} \sum_n a_n P_n(\theta_\gamma) P_n(\varphi), \text{ if the original } \pi^0 \text{ cross}$$

section is written as $d\sigma/d\Omega = \sum_n a_n P_n(\theta_\gamma)$, where $\varphi = \cos^{-1}(1/\beta - u^2/2qE_\gamma)$ is the angle between the observed γ ray and its parent π^0 ; u , β , and q are the π^0 mass, velocity, and momentum in the center-of-mass system respectively; and P_n is the Legendre polynomial of order n . The data were divided into bins of $\Delta(\cos \varphi) = 0.2$ wide and for each bin the coefficients $a_0 P_0(\varphi)$, $a_1 P_1(\varphi)$, and $a_2 P_2(\varphi)$ were determined and plotted. A fit to the various $P_n(\varphi)$ was made to determine the coefficients a_0 , a_1 , and a_2 . The errors associated with these values include 3 sources: (1) statistics; (2) uncertainty in the counter-efficiency at low energies; and (3) uncertainty in the location of the energy E_γ corresponding to a particular value of $\cos \varphi$. In addition, γ -ray yields were also measured at a peak bremsstrahlung energy of 140 mev.

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Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SCINTILLATION CHAMBER WORK AT M.I.T., by H. S. Bridge, D. O. Caldwell and others. [1959] 4p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])

Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Ac-

celerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 572-575.

A brief report is given on fiber scintillation chambers sufficiently large enough to yield a useful rate of events. A chamber of plastic scintillating fibers $5 \times 5 \times 10$ in. is proposed that is thought to meet this requirement. Its reported resolution is expected to be about 1 mm.

1058

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

THE USE OF ELECTROSTATIC GENERATORS AS INJECTOR FOR ELECTRON SYNCHROTRONS, by D. Luckey. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)

Unclassified

Published in Nuclear Instr. and Methods, v. 5: 266-268, Oct. 1959.

Some experiences with the use of electrostatic generators as injectors for electron synchrotrons at Cornell U. and M.I.T. are described. At M.I.T. the injection energy was changed without any other essential modifications to the synchrotron. A factor of 10 in intensity has been obtained, along with greater stability. Space charge does not appear to be the limiting mechanism of the beam current. (Contractor's abstract)

1059

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

NUCLEAR POLARIZATION OF Co^{55} , by R. W. Bauer and M. Deutsch. [1959] [13]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098)

Unclassified

Presented at meeting of the Amer. Phys. Soc., Cleveland, Ohio, Nov. 27-28, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 425-426, Nov. 27, 1959.

Also published in Nuclear Phys., v. 16: 264-277, May 1, 1960.

The angular distribution and linear polarization of the gamma rays emitted from 18-hr Co^{55} , polarized at low temperatures in cerium-magnesium nitrate crystals, have been measured. The amplitude mixing ratios

$\alpha(E2/M1)$ of mixed multipole gamma transitions in Fe^{55}

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have been determined. With a spin of $7/2$ for Co^{55} , we find a spin sequence of $7/2 \rightarrow 5/2 \rightarrow 3/2$ in the main decay in Fe^{55} , and for the 0.935 mev gamma ray a g of $+0.36 \pm 0.11$. A possible spin sequence $5/2 \rightarrow 7/2 \rightarrow 3/2$ in Fe^{55} has been eliminated by our linear polarization measurements. The ratio of the nuclear g -values of Co^{58} and Co^{55} has been found from a simultaneous measurement of the angular distribution of the gamma rays from the two isotopes grown into the same crystals. The magnetic moment of Co^{55} is 5.3 ± 0.4 n.m., if the 1.03 mev beta branch is predominantly a G.T. transition, or 4.6 ± 0.4 n.m., if a pure Fermi transition. (Contractor's abstract)

1060

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

IMAGINARY PART OF THE OPTICAL POTENTIAL, by L. C. Gomes. [1959] [4]p. incl. diagrs. table. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(40-1)2098]) Unclassified

Published in Phys. Rev., v. 116: 1226-1229, Dec. 1, 1959.

The imaginary part of the optical potential has been investigated for low-energy incoming neutrons, by means of the nucleon-nucleon cross sections in nuclear matter. The cross sections have been calculated under the assumption that pair correlations for low excited states of nuclear matter are the same as those formed in the ground state. The dependence of the effective mass on the single-particle momentum has been taken into consideration using an empirical solution which reproduces the present assumptions for the single-particle spectrum. The results have been applied to the nuclear surface in the Thomas-Fermi approximation. The maximum in the imaginary potential was found to be at the surface outside of the half-density radius. For low incident energies it is about 1.5×10^{-13} cm beyond this radius. (Contractor's abstract)

1061

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

MEASUREMENT OF THE SPIN AND PARITY OF THE ANOMALOUS INELASTIC STATES IN Ni^{58} AND Ni^{60} , by M. Crut and N. S. Wall. [1959] [3]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098])

Unclassified

Published in Phys. Rev. Ltrs., v. 3: 520-522, Dec. 1, 1959.

In this note experiments establishing the spin and parity of the 4.5-mev structure in Ni^{58} and Ni^{60} are reported on. Angular distribution of alpha particles scattered from Ni^{58} and Ni^{60} , respectively, leaving the target nucleus in the ground state and 1st excited state are shown. Measurements of the distribution show that the parity of the "anomalous state" in Ni^{58} and Ni^{60} is different from that of the ground state whereas the parity of the 1st excited state is the same as the ground state. The angular correlation results can be interpreted as showing that the "anomalous state" is 3^- and decays to the 1st excited 2^+ state through the emission of electric dipole radiation.

1062

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SEA-LEVEL COSMIC-RAY MASS SPECTRUM IN THE INTERVAL $30m_e$ - $2000m_e$, by G. G. Fazio and M.

Widgoff. [1959] [4]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev., v. 116: 1263-1266, Dec. 1, 1959.

In nuclear emulsion stacks exposed to sea-level cosmic radiation under 180 g cm^{-2} of iron, no evidence for mass values in the regions $30m_e$ to $100m_e$ and $400m_e$ to $900m_e$ was found. If such particles do exist, their intensity relative to that of μ mesons stopping in the same range interval must be as follows: for $30m_e$ to $100m_e$, $\leq 0.13\%$; for $400m_e$ to $900m_e$, $\leq 0.04\%$.

1063

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SEARCH FOR ANOMALOUS LIFETIME VALUES IN SEA-LEVEL COSMIC RADIATION, by G. G. Fazio and D. M. Ritson. [1959] [3]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev., v. 116: 1267-1269, Dec. 1, 1959.

By use of a scintillation counter telescope, sea-level cosmic radiation was investigated for the existence of

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particles of mass greater than $50m_e$, decaying with lifetimes in the msec region. If such particles exist, their intensity, relative to μ mesons, for various lifetime ranges, must be as follows: for 10^{-4} to 10^{-2} sec, $\leq 0.03\%$; for 10^{-4} to 5×10^{-2} sec, $\leq 0.1\%$; for 10^{-4} to 10^{-1} sec, $\leq 0.14\%$; for 10^{-4} to 10^{-1} sec (for decay into a light meson), $\leq 0.03\%$; for 10^{-4} to 1.0 sec, $\leq 1.4\%$.

1054

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

MESON-NUCLEON SCATTERING AND NUCLEAR FORCES, by V. F. Weisskopf. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev., v. 116: 1615-1617 Dec. 15, 1959.

A simple derivation which does not make use of field theory is given of the main results of the static theory of π -meson scattering by nucleons. The derivation serves to elucidate the connection between low-energy meson scattering and the nuclear forces of large distances.

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Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

SEARCH FOR $\pi_{10}^0 \rightarrow 3\gamma$, by R. P. Ely and D. H. Frisch. [1959] [3]p. incl. diag. tables. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev. Ltrs., v. 3: 565-567, Dec. 15, 1959.

This note discusses an experimental search for a neutral meson of isotopic spin zero, using a method which covers only a small part of the possible mass spectrum, and which can detect the 3γ decay of a neutral meson of mechanical spin 1, the π_{10}^0 , but which cannot detect the 2γ decay of the ordinary π^0 . A detailed description of the experimental apparatus is given explaining why it can detect the π_{10}^0 , but not the $\pi^0 2\gamma$ decay. Results, given in table form, show that at $\alpha = 95^\circ$, the net rate observed at 160 mev is $(2.0 \pm 0.6)\%$ of that from 3 pairs of counters counting ordinary π^0 's in the $\alpha = 150^\circ$ position. Only the following conditions

in background considerations are expected to contribute appreciably to this net rate: (1) cosmic-ray coincidences, measured to give $(20 \pm 2)\%$ of the above rate, (2) coincidences between 1 of the electrons and the gamma in the Dalitz pair decays, $\pi^0 \rightarrow e^+ + e^- + \gamma$, estimated to give $(10 \pm 3)\%$ and (3) coincidences between 1 of the γ rays from the π^0 and the nuclear γ ray in the reaction $p + Li^7 \rightarrow Be^8 + \pi^0 \rightarrow Be^8 + \gamma (17 \text{ mev}) + 2\gamma$, estimated to give $(\pm 4)\%$. The corrected net rate at $E_p = 160 \text{ mev}$, after subtracting these 3 backgrounds, is $(1.2 \pm 0.6)\%$ of the $\alpha = 150^\circ$ ordinary π^0 equivalent counting rate.

1066

Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

AN AID IN THE DETERMINATION OF NUCLEAR SPINS, by R. K. Sheline, H. L. Nielsen, and A. Sperduto. [1959] [5]p. incl. diagrs. table. (In cooperation with Florida State U., Tallahassee) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under AT(30-1)2098) Unclassified

Published in Nuclear Phys., v. 14: 140-144, Dec. 1959.

Intensities of the α groups collected in the backward angle from the $Al^{27}(d,\alpha)Mg^{25}$ reaction have been analyzed after recording them on nuclear emulsions over an extended range of excitation. Given intensities are determined with an average deviation of $\approx 15\%$. Normalizing the intensities by $2I + 1$ and barrier penetration factors produces intensities which are the same within an average deviation of 33% . Use of intensities as an aid in determining spin is suggested.

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Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge.

NUCLEAR ORIENTATION OF Mn^{56} , by R. W. Bauer and M. Deutsch. [1959] [7]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [AT(30-1)2098]) Unclassified

Published in Phys. Rev., v. 117: 519-525, Jan. 15, 1960.

The angular distribution and circular polarization of the gamma rays emitted from $2.6\text{-hr } Mn^{56}$, polarized at low temperatures in cerium magnesium nitrate, have been measured. Comparing the angular distribution results with angular correlation data it is possible

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to establish the spins of the 2.65- and 2.98-mev excited states of Fe^{56} as 2 uniquely. The amplitude mixing ratios $\delta(E2/M1)$ for the 1.81- and 2.13-mev γ -rays are shown to be $+0.11 \pm 0.06$ and -0.27 ± 0.03 , respectively.

Gamma anisotropies from aligned Mn^{56} in the same cooling salt have been studied; the results are compared with other Mn alignment experiments. From a simultaneous measurement of the angular distribution of the γ -rays from polarized Mn^{52} and Mn^{56} , the ratio of the nuclear g-values (g_{52}/g_{56}) = 0.47 ± 0.05 has been determined, giving $\mu_{56} = 3.35 \pm 0.35$ nm. The results of the circular polarization experiment determine μ_{56} to be positive. (Contractor's abstract)

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Massachusetts INST. OF Tech. Naval Supersonic Lab., Cambridge.

RESEARCH ON HEAT TRANSFER CHARACTERISTICS OF DIFFUSION BOUNDARY LAYERS. Final rept. Apr. 1959, 7p incl. refs. (Technical rept. no. 374) (AFOSR-TR-59-41) (AF 18(603)82) Unclassified

The mass transfer investigation at the Naval Supersonic Lab is concerned with the consequences of binary-mixture flow in the high-speed boundary layer. Such flow is of interest as a possible means for overcoming the severe thermal problem associated with supersonic flight. The object of the investigation is two-fold: (1) to conduct experimental programs which will enable comparison to be made with available theoretical results which indicate profound alterations of both heat transfer rates and equilibrium temperatures upon the injection of certain types of coolants, and (2) to conduct associated analyses which will further define the limits and effects of both the injection process and mass diffusion phenomena so as to provide some insight into the criteria for such systems.

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Massachusetts inst. of Tech. Naval Supersonic Lab., Cambridge.

AN "INSULATING" BOUNDARY-LAYER EXPERIMENT, by F. H. Durgin. [1959] [2]p. incl. diagr. table. (AF 18(603)82) Unclassified

Published in Aero/Space Sci., v. 26: 450-451, July 1959

Quantitative confirmation of the fact that the heat transfer at any point is influenced by the upstream history of the flow are presented. It is shown that the measurements for laminar flow are 0.5 and 1.5 for m(flat plate) and m(cone) respectively. The turbulent flow calculations

are 0.8 for the flat plate and 1.8 for the cone. It is concluded that the persistence of cooling (the "insulating" property) is appreciable even 1 nose length behind the copper section.

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Massachusetts Inst. of Tech. Naval Supersonic Lab., Cambridge.

SUBLIMATION OF A HEMISPHERE IN SUPERSONIC FLOW, by R. Weiss. July 1959, 61p. incl. illus. diagrs. tables, refs. (Technical rept. no. 391) (AFOSR-TN-59-870) (AF 49(638)245) AD 227553; PB 144496

Unclassified

Mass transfer cooling with a light gas has been shown to reduce the large heat transfer rates to a body that is moving rapidly through the atmosphere. The possibility of using a subliming body so as to provide self governing mass transfer cooling has been suggested. To make a preliminary evaluation of this approach, an investigation of the heat transfer rates to several subliming bodies of hemispherical shape has been carried out. Tests were run at a Mach number of 3.5 with solid carbon-dioxide, naphthalene and camphor, 3 relatively "heavy" materials. Additional tests with camphor models determined the effect of Reynolds number on the heat transfer rate. It was found that heat transfer was reduced in proportion to the mass-injection rate, that a greater reduction was effected with a lesser weight material, and that increasing Reynolds number also produced a lower level of heat transfer coefficient. The bodies tended to assume a conical shape, a phenomenon more noticeable with increasing Reynolds number; only 1 model appeared to have reached a state of equilibrium. The investigation indicated both the feasibility of conducting an experiment of this nature and the applicability of subliming bodies both in reducing and absorbing aerodynamic heating. (Contractor's abstract)

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Massachusetts Inst. of Tech. Naval Supersonic Lab., Cambridge.

AN INVESTIGATION OF POROUS WALL COOLING, by R. P. Bernicker. June 1959, 59p. incl. illus. diagrs. table, refs. (Technical rept. no. 393) (AFOSR-TN-59-873) (AF 49(638)245) AD 227555; PB 144473

Unclassified

Equations are developed to describe the thermal exchange when a coolant is forced through a heated porous wall, and solutions are obtained on the basis of a simplified model consisting of identical cylindrical channels replacing the actual capillary-like passages. The solutions depend upon Reynolds and Prandtl numbers, geometric parameters involving wall porosity and pore size, and Nusselt number. Experiments were performed with 1 family of porous materials, and Nusselt numbers were correlated in terms of Reynolds and Prandtl

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numbers, and porosity. Nusselt number varies almost linearly with Peclet number. Temperature distributions obtained indicate a very small difference between solid and coolant temperatures at the exit surface. (Contractor's abstract)

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Massachusetts Inst. of Tech. Naval Supersonic Lab., Cambridge.

SOME APPROXIMATIONS TO THE SOLUTION TO THE BINARY BOUNDARY-LAYER PROBLEM, by E. E. Covert. Sept. 1959, 23p. incl. diagrs. tables. (Technical rept. no. 390) (AFOSR-TN-59-1091) (AF 49(638)245) AD 235990; PB 147781 Unclassified

Some approximate relations between shear, mass transfer and heat transfer are developed for the case of arbitrary external velocity, blowing distribution, and wall temperature. The approximations are compared with known solutions and are in satisfactory agreement with them. (Contractor's abstract)

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Massachusetts Inst. of Tech. Naval Supersonic Lab., Cambridge.

HEAT AND MASS TRANSFER FOR FLOW PAST AN ARBITRARY CYLINDER, by P. B. Scott. Sept. 1959, 87p. incl. diagrs. tables, refs. (Technical rept. no. 383) (AFOSR-TN-59-1268) (AF 49(638)245) AD 235991 Unclassified

Previous investigators have indicated that heat transfer to aerodynamic surfaces can be materially reduced by the injection of a foreign gas of high specific heat through a porous wall into the boundary layer. A method is presented which determines the heat transfer to a cylinder of arbitrary cross section, undergoing foreign gas injection, and specifically that injection distribution corresponding to an isothermal wall. A step-by-step solution is obtained by matching the boundary-layer flow at any station of a cylinder to the flow at a corresponding station on an equivalent wedge. The necessary parameters are derived by consideration of the boundary-layer equations. The matching criteria are presented and 2 methods of solution (graphical and numerical) are described. The necessary set of wedge flow solutions have been obtained for various wedge apex angles and helium injection. Sample calculations using the numerical method are presented. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A LINEAR CIRCUIT VIEWPOINT ON ERROR-COR-

RECTING CODES, by D. A. Huffman. [1956] [9]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-C39-sc-64637])

Unclassified

Presented at 1956 Symposium on Inform. Theory, Massachusetts Inst. of Tech., Cambridge, Sept. 10-12, 1956.

Published in I.R.E. Trans. on Inform. Theory, v. IT-2: 20-28, Sept. 1956.

Presented at Internat'l. School of Physics, Varrena (Italy), July 7-14, 1958.

Also published in Nuovo Cimento, Series X, Suppl., v. 13: 389-396, 1959.

A linear binary filter has as its output a binary sequence, each digit of which is the result of a parity check on a selection of preceding output digits and of present and preceding digits of the filter input sequence. The terminal properties of these filters may be described by transfer ratios of polynomials in a delay operator. If 2 binary filters have transfer ratios which are reciprocally related then the filters are mutually inverse in the sense that, in a cascade connection, the 2nd filter unscrambles the scrambling produced by the 1st. The coding of a finite sequence of binary information digits for protection against noise may be accomplished by a binary sequence filter, the output of which becomes the sequence to be transmitted. The inverse filter is utilized at the receiver. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OBSERVATIONS ON INHARMONIC SIGNALS (Abstract), by E. DeBoer. [1957] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., New York, May 23-25, 1957.

Published in Jour. Acoust. Soc. Amer., v. 29: 780, June 1957.

Schouten's "residue" can be readily observed when a group of closely spaced Fourier components is presented. Such a sound often exhibits a basic pitch, especially when the complex stimulus is harmonic. The pitch level is then judged to be the fundamental frequency (which in this case equals the difference frequency). In the present study signals consisting of a restricted number of equally spaced components were investigated. The sound observed is steady in both pitch and timbre even when the stimulus is inharmonic. The pitch level however corresponds not necessarily to the

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difference frequency as can be demonstrated when all components are displaced by the same amount in frequency. For small departures from harmonicity, the pitch appears to follow the direction of this frequency shift of the complex. More specifically, the relative pitch change is approximately equal to the relative frequency change of the central component, the timbre not being affected much. The timbre depends strongly upon the relative phases of the components, so that it seems closely tied to the shape of the envelope of the signal's wave form.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TOPOLOGICAL ANALYSIS OF LINEAR NONRECIPROCAL NETWORKS, by S. J. Mason. [1957] [10]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 45: 829-838, June 1957.

Kirchhoff and Maxwell gave us topological inspection rules for evaluating the transmission of a linear reciprocal branch network. With the addition of the unistor, a branch-like element whose current is proportional to one of its two terminal potentials and independent of the other terminal potential, or the gyrator, whose current is proportional to the sum of its two terminal potentials, we can model any linear network, in general nonreciprocal. The point is that the Kirchhoff-Maxwell methods carry over to such networks without change of form, the only modification of the transmission expression being a relatively simple sign rule for gyrator admittances or a relatively simple nullification rule for unistor admittances.

1077

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE DEGREES OF FREEDOM IN RLC NETWORKS, by A. Bers. [1959] [5]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]) Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 91-95, Mar. 1959.

In networks containing only 2 kinds of elements (RL, RC, or LC), the degrees of freedom are usually found from the number of normal modes of oscillation of the system. The normal modes are readily determined from the topology of the subgraphs for each kind of element. In RL and RC networks the degrees of freedom are equal to the number of normal modes, while

in LC networks the degrees of freedom are equal to twice the number of normal modes. The present paper shows that the number of natural frequencies of any RLC network can be determined in a rather simple manner. The known results for networks containing only 2 kinds of elements are shown to be derivable as special cases. The introduction of resistance (loss) into a network (linear system) will usually change the number of degrees of freedom of the network. It is shown here that this change can be accounted for exactly from some of the topological changes in the network.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FM INTERFERENCE AND NOISE SUPPRESSION PROPERTIES OF THE OSCILLATING LIMITER (Abstract), by E. J. Baghdady. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]) Unclassified

Presented at I. R. E. National Convention, New York, Mar. 23-26, 1959.

Published in I. R. E. National Convention Record, Part 8: 13-39, 1959.

A study of the phenomenon of oscillator locking is carried out for oscillators that are built around an amplitude limiter. A theory is presented for the locking mechanism that is involved when one or more signal carriers are impressed at the oscillator input. The bearing of the results upon interference suppression in FM reception is emphasized. Limitations imposed by phase shifts around the loop upon locking range and threshold are discussed. The oscillating limiter is revealed as a remarkable tool for minimizing cochannel FM disturbances, and for suppressing an adjacent-channel signal, whether it be stronger or weaker than the in-band signal. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

REPETITIVE DISCHARGE OF NEURONS, by P. D. Wall. [1959] [16]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]; and Bell Telephone Labs. Inc., National Science Foundation, and Teagle Foundation, Inc.) Unclassified

Published in Jour. Neurophysiol., v. 22: 305-320, May 1959.

The nature and origin of 2 types of "after-discharge" were examined. The 1st occurs in sensory afferent

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fibers to the spinal cord. After the arrival of a single afferent volley, a repetitive antidromic discharge called the dorsal root reflex, DRR, is generated in the terminals of the active fibers and in their passive neighbors. The DRR was set off by stimulation of peripheral nerves. The initial latency and the variation of latency throughout the discharge depends on the nerve stimulated and the strength of stimulation. The pattern of the response differs markedly from that seen in the interneurons on which the fibers end. The time of arrival of the afferent impulse in an afferent fiber does not affect the pattern of the DRR. The interjection of an impulse into a DRR resets the rhythm and it is concluded that the site of origin of the rhythm is within the fiber. "Spontaneous" activity of peripheral sensory endings is similarly reset by the introduction of additional impulse. The 2nd type of "after-discharge" examined was that produced by dorsal horn sensory interneurons after the arrival of a single volley from a peripheral sensory nerve. The pattern of discharge of the sensory interneurons varies among 3 types of responses: a low-frequency short discharge with great variation of latency, a high-frequency prolonged discharge and a short abrupt discharge. The interjection of an additional impulse into the repetitive discharge of an interneuron fails to reset the rhythm and the discussion concludes that the repetitive firing is probably driven by bombardment from other neurons. The "spontaneous" activity of the interneurons is not obviously reset by interjected impulses. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPECTRAL EMISSIVITY OF TUNGSTEN, by R. D. Larrabee. [1959] [7]p. incl. diagrs table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-64637]) AD 221257 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 49: 619-625, June 1959.

An experiment designed to measure the spectral emissivity of tungsten, in which a direct comparison method is utilized so that the spectral emissivity is observed as the ratio of light intensity from a tungsten source to that from a blackbody source, is described. The spectral emissivity was measured over the wavelength interval 310 mμ to 800 mμ and the temperature interval 1600°K to 2400°K. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFECT OF A PLANE ON THE POWER OUTPUT OF A MONOPOLE (Abstract), by G. C. Maling, Jr. [1958]

[1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 115, Jan. 1959.

The presence of a plane boundary is known to affect the power output of a sound source, and the effect is most conveniently expressed as a "power amplification factor (W/W_0)" which will in general depend on type of sound source, distance from plane, and boundary admittance. For a constant strength monopole near a plane with specified normal admittance (real), the power amplification factor can be calculated rigorously in terms of tabulated functions using existing theory on the reflection of a spherical wave from an infinite plane specified by impedance boundary conditions (U. Ingard, Jour. Acoust. Soc. Amer., v. 23: 329, 1951). Plots of W/W_0 as a function of source height are presented for several values of normal admittance including $\beta = 1$.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EQUIVALENT CIRCUIT REPRESENTATION OF A FLEXIBLE, POROUS MEDIUM (Abstract), by W. W. Lang. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 115, Jan. 1959.

As an extension to the general investigation of sound propagation in a flexible, porous medium reported at the Fifty-fifth meeting (Jour. Acoust. Soc. Amer., v. 30: 670 1958), an equivalent circuit representation of such a medium has been developed. At low frequencies a flexible, porous layer which is rigidly backed and locally reacting can be represented by lumped circuit elements. The circuit studied here consists of 2 parallel branches, 1 representing the air enclosed by the structure and the other representing the structure itself. From the specific acoustic impedance of this circuit, the percentage of incident sound energy absorbed at a flexible, porous surface is determined for a range of values of the significant physical constants which characterize the material. Coupling between the structural elements and the air enclosed by the structure is not described by such a simple circuit. The extent to which

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this simple representation described the influence of nonrigidity on the sound energy absorbed by the porous surface is discussed.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EXPERIMENTS ON SCATTERING OF SOUND BY TURBULENCE (Abstract), by M. D. Mintz and U. Ingard. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 115, Jan. 1959.

Some results from field measurements on the scattering of sound have been presented previously. In the present paper, results from laboratory experiments are reported. Pulses of 100 kc/sec sound, transmitted through a region of turbulence, are analyzed by means of a pulse height analyzer and counter. The pulse height distribution is determined for various scattering angles and the corresponding scattered sound energy is evaluated. In addition to these results on scattering of a collimated beam of sound, some preliminary results on the scattering of a cylindrical wave are presented.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LOUDNESS JUDGEMENTS ON CLICKS (Abstract), by C. D. Geisler, C. M. Molnar and others. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 117, Jan. 1959.

Two groups of experiments were performed to study the ways in which listeners will scale and categorize acoustic clicks of different intensities. The 1st group of experiments posed to listeners the task of estimating the numerical magnitude of clicks that varied in intensity over an 80-db range. In 1 experiment a standard click was presented 10 times at the beginning of each test series (81 clicks), in another experiment a standard click was presented before each stimulus, and in a 3rd experiment no standard click was given. In a 2nd

series of experiments, the listeners were asked to assign clicks according to their loudness to 1 of 5 categories; the intensity ranges covered and the number of stimulus levels varied. The results of the magnitude estimation experiments agree reasonably well with the

Stevens scale of loudness $L = KI^{0.3}$; there is the usual amount of inter- and intra-listener variability. The results reflect to some extent the subjects' peculiarities in the use of numbers. The results of the categorization experiments demonstrate that the assignment of clicks to loudness categories depends not only on the intensity of the particular click which is being judged but also to some extent upon the stimulus ensemble as a whole.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

MODE COUPLING ON A STRING - AN EXAMPLE OF MAGNETOMECHANICS OF EXTENDED SYSTEMS (Abstract), by U. Ingard. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 114, Jan. 1959.

The motion of a stretched string, forming 1 part of an electric circuit, is studied as the string oscillates in a magnetic field. Special attention is paid to the mode coupling provided by the magnetic field, the rate of growth of higher modes as the string is released from its fundamental mode displacement, and the "equilibrium"-energy distribution on the various modes of the string. In addition to the study of the finite string, the scattering of a wave on an infinite string running through a magnetic field is discussed.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOISE GENERATION BY INTERACTING AIR JETS (Abstract), by U. Ingard and G. C. Maling, Jr. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 117, Jan. 1959.

Measurements of the noise produced as a result of the

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interaction of 2 air jets at angles of intersection between 0° and 180° have been reported. The acoustic power from the jets was found to increase with the angle of intersection and reach a maximum when the angle is about 90° . In the present case (jet diam 2 cm, Mach number $M \sim 0.5$) the maximum value of the interaction noise power is about 12 db larger than the power from the 2 jets separately. As an extension of this work measurements have been made as a function of the vertical separation of the jets, keeping the angle of intersection constant, equal to 90° . An attempt is made to explain the results from these experiments in terms of the effect of the mean gradients in the flow, which leads to a radiated sound power proportional to the integral of $u'^6 |\text{grad } U|^2$ (Lighthill, 1952) where u' and U are the local fluctuating and mean velocities of the jets, respectively. The experimental results can be satisfactorily explained on this basis since the noise from 2 interacting jets seems to be predominantly a result of mean shear. On the basis of these results the noise from a single jet is discussed as a sum of contributions proportional to u'^8 and $u'^6 |\text{grad } U|^2$, respectively, and the relative importance of these terms is discussed.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

"STEADY-STATE" AUDITORY NERVE POTENTIALS FOR DIFFERENT STIMULUS REPETITION RATES (Abstract), by W. T. Peake, M. H. Goldstein, Jr., and N. Y-S. Kiang. [1958] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Chicago, Ill., Nov. 20-22, 1958.

Published in Jour. Acoust. Soc. Amer., v. 31: 123, Jan. 1959.

Two major difficulties encountered in recording auditory nerve potentials at high stimulus repetition rates are (1) the small amplitude of the responses, and (2) the possible contamination by aural microphonics. With the aid of an average response computer, the behavior of the N_1 and N_2 components to weak bursts of noise have been studied; the averages were computed for time intervals that start several seconds after the onset of the stimulus. Gross electrodes were placed either near the round window or in the vicinity of the internal auditory meatus of anesthetized cats. This procedure optimizes the detection of the neural components and the amplitudes of the "steady-state" neural responses can be measured as the repetition rate is changed. Above 10/sec the amplitude decreases continuously as the repetition rate increases. There are irregularities for rates near 600/sec, which may result from the interaction of N_1 with the previous N_2 . The maximum rate at

which synchronized activity is detectable lies around 3000/sec. The plot of amplitude vs rate does not exhibit plateaus as Derbyshire and Davis found in recording "maximal unequilibrated" responses at the onset of pure tone stimuli.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELASTIC CONSTANTS OF INDIUM ANTIMONIDE FROM 4.2°K TO 300°K , by L. J. Slutsky and C. W. Garland. [1959] [3]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Published in Phys. Rev., v. 113: 167-169, Jan. 1, 1959.

The adiabatic elastic constants of a single crystal of indium antimonide have been measured by an ultrasonic pulse technique in which 10-mc/sec acoustic waves are employed. The elastic constants extrapolated to 0°K are, in units of 10^{12} dynes/cm², $c_{11} = 0.6918$, $c_{12} = 0.3788$, and $c_{44} = 0.3132$. A Debye characteristic temperature, θ , of $205^\circ \pm 2^\circ\text{K}$ at 0°K was calculated from these values of the elastic constants. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

LIGHT, by G. W. Stroke. Jan. 9, 1959, 31p. incl. diagrs. refs. (Technical rept. no. 348) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108] AD 216193
Unclassified

This work is based on an article for publication in the McGraw-Hill Encyclopedia of Science and Technology. The following topics are covered: General Nature and Theories of Light, Classification of Phenomena and Theories Involving Light, Electromagnetic Wave Character of Light, Relativistic Effects in the Behavior of Light, and the Corpuscular Nature of Light. The treatment places particular emphasis on light as a group of electromagnetic radiations. It singles out many of the fundamental properties of light that require further investigation—for the study of light in its own right, and for the information that it gives about the subatomic world, as well as about the universe. The well-known electromagnetic and corpuscular characters of light, which form the subject matter of the classical electromagnetic theory and of quantum mechanics, are recalled, and a detailed description of the relativistic effects in the behavior of light is given. The effects that are described by the General Theory of

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Relativity are not incorporated in the present quantum theories dealing with light. A need appears, therefore, for the formulation of a theory of light that would extend beyond the present quantum theories and incorporate all of the known properties of electromagnetic radiations. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DETERMINATION OF THE DIPOLE MOMENT AND ISOTOPE SHIFT OF RADIOACTIVE Hg^{197} BY "DOUBLE RESONANCE", by A. C. Melissinos. [1959] [4]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: Jan. 28, 1959.

Also published in Phys. Rev., v. 115: 126-129, July 1, 1959.

Paramagnetic resonance was established between m-sublevels ($\Delta m = +1$, $\Delta F = 0$) of the 3P_1 state of radioactive Hg^{197} at 3000 mc/sec. From these data the nuclear interaction constant A was found to be $(513.5 \pm 1) \times 10^{-3} \text{ cm}^{-1}$, and barring hfs anomalies it leads to a ratio of moments $\mu_{197}/\mu_{199} = A_{197}/A_{199} = 1.045$; further, the nuclear spin of Hg^{197} was ascertained to be $1/2$. The double resonance was combined with magneto-optic scanning to give the isotope shift of Hg^{197} , which was found to be in the 2537 Å line $+ (91 \pm 5) \times 10^{-3} \text{ cm}^{-1}$ from Hg^{198} . The radioactive mercury was produced by $\text{Au}^{197} (d, 2n) \text{Hg}^{197}$ reaction and used in vapor form. Satisfactory signals were obtained with as few as 3×10^{12} atoms.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CODING AND INFORMATION THEORY, by P. Elias. [1959] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Published in Rev. Modern Phys., v. 31: 221-226, Jan. 1959.

An introduction, in non-mathematical terms of "information theory", that is, the generation, storage, transmission, and processing of information is discussed. Some possible applications to biology are pointed out with emphasis placed on applications to chemical specificity in biological systems.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFICIENCY OF FREQUENCY MEASUREMENTS WITH AN ATOMIC CLOCK, by M. Peter and M. W. P. Strandberg. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Published in Proc. Inst. Radio Engineers, v. 48: 92-93, Jan. 1959.

A high-efficiency frequency measurement was made by building a lossless interaction space and placing molecules in it that were ready to absorb the radiations of a frequency, $\omega_a < \omega_0 < \omega_b$. The measurement was carried out by sending a certain amount of radiation into the interaction space at each different frequency and have it reflected back. The only energy used is at the resonance frequency at which the energy frequency is absorbed. The efficiency of the system is calculated to be 0.01. This efficient system is, nevertheless, not one of optimum efficiency. To obtain an atomic clock of nearly optimum efficiency, a spectroscope with a sufficiently narrow natural width must be used. However, the design of this system causes a loss in reliability.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ELASTIC CONSTANTS OF SODIUM IODIDE FROM 180°K TO 300°K, by R. Daiven and C. W. Garland. [1959] [2]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Alfred P. Sloan Foundation)
Unclassified

Published in Jour. Chem. Phys., v. 30: 346-347, Jan. 1959.

The adiabatic elastic constants of a single crystal of sodium iodide have been measured by an ultrasonic pulse technique. An extrapolation was made to 0°K and a Debye characteristic temperature, θ_0 , of 167° was calculated. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THE INTERACTION OF MICROWAVES WITH GAS-DISCHARGE PLASMAS, by S. C. Brown. [1959] [4]p. incl. diags. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Atomic Energy Commission) Unclassified

Published in I.R.E. Trans. on Microwave Theory and Tech., v. MIT-7: 69-72, Jan. 1959.

The interaction of microwaves with gas-discharge plasmas provides a valuable tool for studying the fundamentals of gas-discharge phenomena and methods of controlling and switching microwave power. A summary of the present state of knowledge in this field is presented by using as particular examples the interaction of high density and low density gas-discharge plasmas in S-band resonant cavities, both in the presence and absence of de magnetic fields. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A TUNABLE MASER AMPLIFIER WITH LARGE BANDWIDTH, by R. J. Morris, R. L. Kyhl, and M. W. P. Strandberg. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 80-81, Jan. 1959.

A solid-state single-cavity X-band maser that has a 20-mc bandwidth at 10-db gain with a bath temperature of 4.2°K is described. The maser crystal is ruby ($\text{Al}_2\text{O}_3\text{-Cr}_2\text{O}_3$) chromium being the paramagnetic ion. It is placed in the short-circuited end of a 1-cm square waveguide. This maser has complete action in the absence of cavity resonance at the pumping frequency and allows the amplifier to be operated at any frequency in the signal tuning range. The details of its construction are further pointed out along with its outstanding features.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPIN-LATTICE RELAXATION FROM STATE OF NEGATIVE SUSCEPTIBILITY, by S. A. Collins, Jr., R. L. Kyhl, and M. W. P. Strandberg. [1959] [3]p. incl.

diags. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])

Unclassified

Published in Phys. Rev. Ltrs., v. 2: 88-90, Feb. 1, 1959.

A state of negative magnetic susceptibility is demonstrated in potassium chromicyanide by using a 180° pulse technique. The spin-lattice relaxation from this state is observed in the time domain, and the complex susceptibility shows no change in slope as it passes through zero.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

EFFECT OF STIMULUS REPETITION RATE ON AUDITORY NERVE POTENTIALS, by W. T. Peake, M. H. Goldstein, Jr., and N. Y-S. Kiang. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at Second annual meeting of the Biophys. Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program and Abstracts, p. J-3.

In order to study the potentials of the auditory nerve at high stimulus repetition rates, a special-purpose digital computer has been utilized for computing the average of responses recorded from gross electrodes near the round window and near the internal auditory meatus of anesthetized cats. This technique offers the advantage of increasing the ratio of the neural response amplitude to the background noise. Furthermore, if bursts of noise are used as stimuli, the cochlear microphonic potential is a random waveform with zero mean, whereas the neural response approaches a nonzero average value for large numbers of responses. The neural potentials have been measured during the onset and in the "steady state" for various repetition rates of the noise bursts. If the amplitude of neural potentials is plotted against stimulus repetition rate, results are obtained that can be interpreted in terms of interactions of responses from neural units.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A MODEL FOR RELATING RESPONSES RECORDED BY GROSS ELECTRODES TO ACTIVITY OF NEURAL UNITS (Abstract), by M. H. Goldstein, Jr. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

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Presented at Second annual meeting of the Biophys. Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program and Abstracts, p. G-8.

A probabilistic model that relates statistics of gross responses to the first-order statistics of the population of contributing units is discussed. Of necessity, the formal postulates of the model are greatly simplified in terms of known neurophysiological processes. The basic postulates concerning the model are: (1) In any very small unit of time Δt , a neural unit (NU) may either "fire" or "not fire"; (2) If an NU fires in the interval $t' < t < t' + \Delta t$, it contributes the unit waveform $U(t - t')$ to the gross response $G(t)$; (3) The probability that one of the NU's of a population will fire during the interval Δt varies as the length of the interval, and is equal to $a(t') \Delta t$; (4) The probability that more than one NU in the population fires in an interval, Δt , is negligible; (5) The gross response, $G(t)$, is the linear summation of waveforms from the units of population. The postulated model leads to the following simple relations between $U(t)$, $a(t)$, and the mean and variance of the gross response: $G(t) =$

$$\int_{-\infty}^t U(t-\tau) a(\tau) d\tau; \sigma^2(t) = \int_{-\infty}^t U^2(t-\tau) a(\tau) d\tau. \text{ The}$$

uses and limitations of this model in the interpretation of certain experimental data will be considered.

1109

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME STATISTICS OF THE ELECTROENCEPHALOGRAM, WITH EMPHASIS UPON AUTOCORRELATION (Abstract), by T. Weiss. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at Second annual meeting of the Biophys. Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program and Abstracts, p. J-8.

One goal of quantitative studies of physical phenomena consists in transforming a set of measured variables into another set that will describe the phenomenon under investigation in terms of meaningful parameters. Most analyses of brain waves by means of autocorrelation functions that have been carried out seem to have been based on 2 implicit assumptions: (1) that frequency-emphasizing transformations (such as autocorrelation) are relevant to the study of the EEG and (2) that probabilistic models (inherent in the use of autocorrelation analysis) are applicable. Both these assumptions were examined in the present investigation which concerned itself with the problem of estimating the autocorrelation function of the EEG from a finite

sample of the EEG time series. A narrow-band, Gaussian noise model was assumed in order to study the errors that arise from the estimation of the autocorrelation function on the basis of a finite sample of the time series. The results obtained showed in particular that the cyclic activity exhibited by EEG correlograms for "long delays" may arise from such errors of truncation.

1110

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STATISTICAL ANALYSES OF EVOKED ELECTRO-CORTICAL ACTIVITY (Abstract), by T. Sandel, T. Weiss, and C. E. Molnar. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at Second annual meeting of the Biophys. Soc., Pittsburgh, Pa., Feb. 25-27, 1959.

Published in 1959 meeting of the Biophys. Soc. Program and Abstracts, p. J-7.

Sensory stimuli produce evoked responses, at the mammalian cerebral cortex, whose quantitative description requires statistical analysis. The cortical activity evoked by various auditory stimuli in the unanesthetized cat has been studied. Such an approach is predicated on large samples of evoked responses, and hence various digital computer techniques have been used for the analysis of the recorded data. The analysis consists of: (a) averaging large numbers of responses evoked by invariant stimuli; (b) obtaining amplitude distributions at various times following the delivery of the stimulus; and (c) computing measures of central tendency and dispersion for these amplitude distributions. The stimuli have been bursts of tone, bursts of noise, and clicks. Data are presented and discussed in terms of the representation of auditory signals at the cortex.

1101

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HIGH-CURRENT ION SOURCE, by R. G. Meyerand, Jr. and S. C. Brown. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Rev. Scient. Instr., v. 30: 110-111, Feb. 1959.

A high-current ion source is described that is of simple design and construction. It is capable of producing an ion beam of $\frac{1}{2}$ amp. The energy spread of ions is large. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

MEASUREMENTS OF MICROWAVE NOISE RADIATION FROM PLASMAS (Abstract), by G. Bekefi and J. L. Hirshfield. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Atomic Energy Commission)

Unclassified

Presented at Eleventh Annual Gaseous Electronics Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 117, Mar. 6, 1959.

The microwave noise power radiated from the positive column of a dc discharge in helium has been investigated over a large range of plasma parameters. Measurements were made by means of a 3000 mc/sec radiometer which has a 2 mc/sec band width and a sensitivity of 10^{-16} w. The noise power emitted radially from the plasma column was measured over a range of electron density from 10^8 to 10^{13} cm⁻³ and over a range of gas pressure from 0.05 to 20 mm Hg. The observed changes in the radiated noise power with electron density are attributed to the changes of opacity that the plasma presents to the electromagnetic waves generated within its volume. The nature of these variations, in which the plasma changes from a transparent to an opaque medium, can be calculated from the known attenuation sustained by an electromagnetic wave as it progresses through the plasma. In addition, a study has been made of the noise radiation which results from the application of a dc magnetic field along the plasma column. Observed resonances in the emission will be discussed.

1103

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CODING THEOREMS FOR A DISCRETE SOURCE WITH A FINITE CRITERION, by C. E. Shannon. [1959] [2]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])

Unclassified

Presented at I.R.E. Nat'l. Convention, New York, Mar. 23-26, 1959.

Published in I.R.E. Nat'l. Convention Record, Pt. 4: 142-163, 1959.

Also published in Information and Decision Processes, New York, McGraw Hill, 1959, p. 93-126.

Consider a discrete source producing a sequence of message letters from a finite alphabet. A single letter distortion measure is given by a non-negative matrix (d_{ij}) . The entry d_{ij} measures the "cost" or "distortion" if letter i is reproduced at the receiver as letter j . The average distortion of a communications system (source-coder-noisy channel-decoder) is taken to be $d = \sum_{i,j} P_{ij} d_{ij}$ where P_{ij} is the probability of i being reproduced as j . It is shown that there is a function $R(d)$ that measures the "equivalent rate" of the source for a given level of distortion. For coding purposes where a level d of distortion can be tolerated, the source acts like one with information rate $R(d)$. Methods are given for calculating $R(d)$, and various properties discussed. Finally, generalizations to ergodic sources, to continuous sources, and to distortion measures involving blocks of letters are developed. (Contractor's abstract)

1104

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FM INTERFERENCE AND NOISE-SUPPRESSION PROPERTIES OF THE OSCILLATING LIMITER, by E. J. Baghdady. [1959] [27]p. incl. diagrs. table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])

Unclassified

Presented at I.R.E. Nat'l. Convention, New York, Mar. 23-26, 1959.

Published in I.R.E. Nat'l. Convention Record, Pt. 8: 13-39, 1959.

An amplitude limiter with regenerative feedback can, under appropriate conditions, provide an effective tool for suppressing interference from undesired signals, as well as interstation noise. The amount of positive narrow-band feedback that is prescribed for marked improvement in the stronger-signal capture performance causes the limiter to oscillate in the absence of an input signal. Although oscillation results in automatic noise squelch, it also imposes limitations on the frequencies and minimum amplitudes of receivable signals, in the form of a locking frequency range and a locking threshold. The alleviation of these limitations requires careful design of the feedback phase characteristic. The theoretical discussion is followed by a summary of experimental data which brings out several important aspects of oscillating-limiter operation. (Contractor's abstract)

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1105

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

ELECTRONIC g FACTORS FOR FREE ATOMIC STATES-Cl³⁵ (Abstract), by G. J. Wolga and M. W. P. Strandberg. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-79108]) Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 153, Mar. 30, 1959.

The magnetic hyperfine energy levels of the 2P_{3/2} free atomic ground state of Cl³⁵ have been investigated by the method of paramagnetic resonance. The atomic Cl³⁵ was produced in a microwave gas discharge at 3000 mc. A flow system enabled observation of the atomic state before recombination. Absorptions corresponding to the $\Delta M_J = \pm 1$, $\Delta M_I = 0$ selection rules were observed between the hyperfine states of both Cl³⁵ and Cl³⁷. The two isotopes were distinguished by the relative intensities of the lines. The transitions occurred at 8993 mc within the range 4600-5000 gauss. Numerical solutions of the secular equations were used with atomic beam values of a and b to obtain the atomic g_J factor for Cl³⁵. The result is $g_J = 1.33376 \pm 0.00007$. This is to be compared with the value of $g_J = 1.3341$ assuming L - S coupling in the 2P_{3/2} state with $g_L = 1.0000$, $g_S = 2.0023$.

1106

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

ELECTROPHORETIC VELOCITY OF SPHERICAL LYOPHOBIC COLLOID PARTICLES (Abstract), by A. L. Loeb, P. H. Wiersema, and J. T. G. Overbeek. [1959] [1]p. [DA 36-039-sc-78108] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 138, Mar. 30, 1959.

The speed, U, of colloid particles in an external electric field depends upon the electrical potential, ζ , at the interface between particles and liquid. A relationship between U and ζ , based on a series expansion in ζ was previously established, but it is valid only for low values of ζ . The present approach is based upon the Gouy-Chapman distribution of charge and potential

and its perturbation by the applied electric field. The resulting nonlinear system of 5 simultaneous transcendental equations has been evaluated by electronic computation, and the results are found to agree with those of Overbeek for low values of ζ . Special attention is given the relaxation effect in electrophoretic transport.

1107

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

NUCLEAR RESONANCE SPECTRA OF HINDRED ROTATORS (Abstract), by J. S. Waugh and R. W. Fessenden. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, Signal Corps under [DA 36-039-sc-78108], and Alfred P. Sloan Foundation) Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 162, Mar. 30, 1959.

Chemical shifts and spin-spin coupling constants observed in most substituted ethanes are averages over internal rotation. In molecules of sufficiently low symmetry they are experimentally temperature-dependent and reflect the degree of rotational hindrance. By means of suitable approximations one can thus estimate the relative stabilities of rotational isomers. It is found, for example, that the two distinct isomers of CHCl₂ - CClF₂ differ in energy by about 2.2 kcal/mol. The assumptions required in such measurements will be discussed, with reference to CH₂Br - CF₂Br¹ and CHClBr - CF₂Br as further examples.

1108

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FULL DECODABLE CODE-WORD SETS, by M. P. Schützenberger and R. S. Marcus. [1959] [4]p. incl. illus. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221310 Unclassified

Also published in I.R.E. Trans. on Inform. Theory, v. IT-5: 12-15, Mar. 1959.

The question of how the decodability condition imposes restrictions on a set of code words is discussed. A generating function is defined that describes the composition of the code words. The relation between the generating function and a full set of code words is found. This relation shows that the sum of arbitrary

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probabilities associated with the words of a full set must be one. A full set of code words is 1 to which no code can be added and still keep the set decodable. It is also shown that a full set is completable. For a completable set of code words any string of symbols can be made into a sentence by adding a suitable prefix and a suffix. (Contractor's abstract)

1109

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HAZARDS AND DELAYS IN ASYNCHRONOUS SEQUENTIAL SWITCHING CIRCUITS, by S. H. Unger. [1959] [14]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 12-25, Mar. 1959.

This paper is concerned with asynchronous, sequential switching circuits in which the variables are represented by voltage levels, not by pulses. The effects of arbitrarily located stray delays in such circuits are analyzed, and it is shown that, for a certain class of functions, proper operation can be assured regardless of the presence of stray delays and without the introduction of delay elements by the designer. All other functions require at least one delay element in their circuit realizations to insure against hazards. In the latter case it is shown that a single delay element is always sufficient. The price that must be paid for minimizing the number of delay elements is that of greater circuit complexity. (Contractor's abstract)

1110

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HYPERFINE INTERACTIONS IN F-CENTER PARAMAGNETIC-RESONANCE SPECTRA IN LiF AND NaF, by G. J. Wolga and M. W. P. Strandberg. [1959] [15]p. incl. illus. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Published in Jour. Phys. and Chem. Solids, v. 9: 309-319, Mar. 1959.

The method of paramagnetic resonance is used to study the magnetic-energy levels of F-centers in LiF and NaF. The microwave absorption spectra show a set of nearly resolved transitions; each crystal has an odd number of almost equally spaced lines symmetrically located about a central resonance. The spectra are found to be isotropic with respect to relative orientation of the 100-axis and the applied magnetic field. The

scalar magnetic hyperfine interaction and the spectroscopic splitting factor are determined from experimental data. The experimental results are interpreted on the basis of the de Boer model of the F-center, and determine the probability density of the F-electron wave function at the sites of the nearest-neighbor nuclei. The line breadth of the inhomogeneously broadened spin packets is obtained from the dependence of the spectrum on the ratio of line width to hyperfine interaction. The packet breadth is attributed to unresolved hyperfine interaction with further nuclei, and yields an estimate of the scalar hyperfine interaction with the next-nearest-neighbor nuclei. The observed spectroscopic splitting factors, corrected for the hyperfine interaction shift, are found to be smaller than the free-electron value. This difference is attributed to spin-orbit coupling with excited states of higher orbital angular momentum, and it yields an estimate for the expectation value of $(1/r^3)$. The predictions of the theory of inhomogeneous broadening on the dependence of the absorption upon microwave power are confirmed. (Contractor's abstract)

1111

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

OPTICAL METHOD FOR DETERMINING THE C AXIS OF RUBY BOULES, by R. D. Mattuck and M. W. P. Strandberg. [1959] [2]p. incl. diagrs. table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Published in Rev. Scient. Instr., v. 30: 195-196, Mar. 1959.

A simple method is described for locating the C axis of an uncut ruby crystal. The procedure involves measurement of the angular position of the ruby for zero light transmission when it is placed between crossed polarizer and analyzer. The precision is $\pm 1^\circ$. (Contractor's abstract)

1112

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

THERMIONIC DIODE AS A HEAT-TO-ELECTRICAL-POWER TRANSDUCER, by W. B. Nottingham. [1959] [5]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])
Unclassified

Published in Jour. Appl. Phys., v. 30: 413-417, Mar. 1959.

The high-vacuum thermionic diode is shown to be capable of converting heat to electric power. For this

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purpose, a low work-function collector, a small spacing, and sufficient temperature difference between the emitter and the collector are necessary. A detailed understanding of both thermionic emission and space-charge phenomena are needed for evaluating the effectiveness of this transducer. With V_R defined as the critical bias potential that gives zero potential gradient at the collector, the maximum available power is given by the relation $3.7 \times 10^{-6} V_T^{\frac{1}{2}} (V_R^2 / \omega^2)$ watts/m². Here, V_T is the voltage equivalent of the temperature $T/11600$. In the range of emitter temperature from 1200-1700°K, the most optimistic conversion efficiency lies between 3 and 4% for a diode of 0.001-in. spacing. With a suitable choice of emitter inhomogeneity, the introduction of cesium vapor should improve the efficiency of this device. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

RESPONSES OF THE AUDITORY CORTEX TO REPETITIVE ACOUSTIC STIMULI, by M. H. Goldstein, Jr., N. Y-S. Kiang, and R. M. Brown. [1959] [9]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 356-364, Mar. 1959.

Electrical responses to low-intensity repetitive clicks and bursts of noise were recorded from the cat auditory cortex. Responses decrease in size as the repetition rate is increased, and for rates higher than 50/sec are smaller than the "ongoing" activity of the cortex and become difficult to detect visually. An electronic average response computer was used to detect responses to high rates of stimulation. Stimulus-locked responses to clicks and bursts of noise were found for rates up to 200/sec in unanesthetized cats, but only up to 100/sec after anesthetization. (Contractor's abstract)

1114

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

USE OF PARAMAGNETIC-RESONANCE TECHNIQUES IN THE STUDY OF ATOMIC OXYGEN RECOMBINATION, by S. Krongelb and M. W. P. Strandberg. [Apr. 27, 1959] [15]p. incl. diagrs. refs. (Technical rept. no. 291) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 232772 Unclassified

Published in Jour. Chem. Phys., v. 31: 1196-1210, Nov. 1959.

A method of making measurements of atomic recombination times with the use of a paramagnetic-resonance spectrometer and its advantages are described. The theory of the paramagnetic-resonance spectrometer applied to these measurements is presented. Methods for using both diffusion and flow systems for determining surface and volume recombination coefficients are analyzed. The operation of the system that was used is illustrated for atomic oxygen recombination. The surface recombination coefficient for oxygen atoms on a quartz surface is shown to be 3.2×10^{-4} per collision, and the 2nd-order volume recombination coefficient was less accurately determined as 5×10^{15} cm⁶ mol⁻² sec⁻¹. The measurement of the diffusion coefficient of atomic oxygen is described. The possible application of these methods to further study of reaction rates is discussed. (Contractor's abstract)

1115

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

BRIDGE FOR MEASURING THE IMPEDANCE OF METAL MICROELECTRODES, by R. C. Gesteland and B. Howland. [1959] [3]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Bell Telephone Labs., Inc.) AD 221256 Unclassified

Published in Rev. Scient. Instr., v. 30: 262-264, Apr. 1959.

An ac bridge for measuring the series components of high-impedance metal-liquid interfaces is described. The real and imaginary components of the impedance may vary over a wide range. All frequency-independent residual error-introducing elements in the measuring circuit may be balanced out through a single square-wave initial balance step. This allows accurate, direct-reading measurement of the unknown. The bridge design is based upon superposition of frequency-independent bridge circuits. (Contractor's abstract)

1116

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON TONE IN CROW, by G. H. Matthews. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Internat'l. Jour. Amer. Linguistics, v. 25: 135-136, Apr. 1959.

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Following a review of previous solutions to the problem of phonemicizing the tones in Crow, another is offered which makes use of the syntactic structure of the language. This solution uses a phonemic notation and a set of 5 ordered rules that are applied thereto. These results can be incorporated into a complete phonology of Crow. (Contractor's abstract)

1117

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROTO-SIOUAN KINSHIP TERMINOLOGY, by G. H. Matthews. [1959] [27]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Amer. Anthropologist, v. 61: 252-278, Apr. 1959.

An attempt is made to reconstruct the Proto-Siouan kinship system by the theory of linguistic change which reconstructs the kinship terms and their uses for a protolanguage postulated as the source of 2 or more languages. In this method the facts of 2 or more languages that are presumed to be related are manipulated in certain prescribed ways, with the result that facts about the common source for these languages are derived. Another method at arriving at an earlier stage of a language is known as the internal reconstruction. This method compares the facts of a single language and infers from certain types of alternation and from irregularities, facts about an earlier stage of that language, usually called a prelanguage. By applying this method to PSI, it is possible to postulate certain sound changes that occurred in Pre-Siouan. The internally reconstructed forms also provide possible reconstructions for some structural features of the PSI system.

1118

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SENSORY PERFORMANCE OF ORGANISMS, by W. A. Rosenblith. [1959] [7]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221259 Unclassified

Also published in Rev. Modern Phys., v. 31: 485-491, Apr. 1959.

Experiments are described which were designed to discover how man detects, orders, and identifies events in his environment to which his sense organs are sensitive. This kind of study (psychophysics) tries to apply quantitative methods to sensory communications. One conclusion drawn from the experiments is that

the analysis of sensory information occupies considerable time in relation to the amount of information transmitted.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME QUANTIFIABLE ASPECTS OF THE ELECTRICAL ACTIVITY OF THE NERVOUS SYSTEM (WITH EMPHASIS UPON RESPONSES TO SENSORY STIMULI), by W. A. Rosenblith. [1959] [14]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221258 Unclassified

Also published in Rev. Modern Phys., v. 31: 532-545, Apr. 1959.

A study of the electrical responses in the human nervous system, evoked by sensory stimuli is discussed. In addition to measuring the electric potential of single electrodes an attempt is made to observe the pattern of responses when a "population" of neural units are mutually interacting. In this way it is hoped to study the "state" of the organism as it reacts selectively to sensory stimulation. The interpretation of electroencephalogram patterns is an essential part of the techniques employed.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STRONG COUPLING IN NUCLEAR RESONANCE SPECTRA. I. THE FIVE-SPIN SYSTEM OF trans-PROPE-NYLBENZENE, by R. W. Fessenden and J. S. Waugh. [1959] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Jour. Chem. Phys., v. 30: 944-949, Apr. 1959.

Energy levels and allowed transitions are calculated for a system of five spin- $\frac{1}{2}$ particles of the type ABX_3 . An extension to the more general system ABC_3 is made by perturbation theory. The results are applied to an analysis of the proton resonance spectrum of trans-propenylbenzene, and it is found that at least one spin-spin coupling constant is negative. An "anomalous" spectrum previously reported, which shows superficial resemblances to the one studied here, is explained by assuming the presence of an impurity. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON THE MODE OF CONVERGENCE AND ITS CORRECTION BY METHODS OF LINEAR SUMMABILITY, by M. V. Cerrillo. [May 3, 1959] 149p. incl. illus. tables, refs. (Technical rept. no. 269) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 246123 Unclassified

A discussion is presented of some questions relating to the behavior of the convergence of certain sequences, which are of interest in the theory of the synthesis of linear systems, toward a limit function that describes the actual behavior of linear systems under the influence of a class of excitation functions. The dynamical behavior of linear systems is given by integral equations representing linear operators and functionals. Convolution, Laplace, Fourier, and other integrals play an important role in these representations. Solutions of these representative integrals are frequently obtained in the form of infinite series. The sequences are generated by the partial sums of finite order of these series. These sequences represent an approximate solution to the integral, and are valid in certain preselected intervals of time. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SAMPLING MODELS FOR LINEAR TIME-VARIANT FILTERS, by T. Kallath. May 25, 1959, 47p. refs. (Technical rept. no. 352) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 230489 Unclassified

A large class of communication channels can be represented by linear time-variant filters. Different constraints can be imposed on these filters in order to simulate the actual operating conditions of such channels. The constraints permit the original filter to be replaced by another (simpler) filter that imitates the original filter under the operating constraints. These new filters need not resemble the physical channel at all, and need not be equivalent to the actual channel, except under the given constraints. The constraints considered are those of finite input and output channel signals and finite channel memory. Other cases can be studied by similar methods. Methods of characterizing linear time-variant filters are investigated in order to determine the most convenient descriptions for the different constraints. These descriptions are used to obtain sampling theorems and models for the filter under the various constraints. The theorems are used to find the conditions under which a linear time-variant filter can be determined by input-output measurements only. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME RECENT SIMPLIFICATIONS OF THE THEORY OF FINITE AUTOMATA, by R. C. Jeffrey. May 27, 1959, 12p. incl. diagrs. (Technical rept. no. 219) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 218936 Unclassified

Automata are defined as 4-termed relations (sets of quadruples). Reduced automata, that is, automata in which the states serve as output symbols, are defined as 3-termed relations (sets of triples). A method is given for replacing the nodes and arrows in the graphs of such relations by neurons or by other logical elements in such a way that the resulting net realizes the corresponding automaton. This method is applicable whether or not the relation corresponds to a single-valued function; that is, whether or not the next state of the automaton is uniquely determined by the present state and input symbol. Also proven is that a set which does not contain the word of length zero is representable by a reduced finite automaton if and only if it is representable by a nonreduced finite automaton. (Contractor's abstract)

1124

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NONLINEAR PROPERTIES OF FM LIMITER, by L. C. Bahiana. May 29, 1959, 47p. incl. diagrs. tables, refs. (Technical rept. no. 350) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 228014 Unclassified

A resistive model for the double-diode amplitude limiter is used in an investigation of the characteristics of a double-diode tuned limiter. It is assumed that the tuned circuit can be replaced by an equivalent resistance (equal to the impedance of the tuned circuit at the given driving frequency). The crystal diodes are assumed to follow a square-law volt-ampere dependence when they are conducting. A limiter coefficient K_L is suggested and shown to be a convenient parameter for defining the limiter performance. The characteristics calculated on the basis of this theory agree, within a reasonable degree of approximation, with available experimental data. To solve the limiter problem with the tuned circuit shunted by ideal diodes, a breakpoint analysis that results in a set of transcendental equations, called the limiter equations, is carried out. In view of the complexity of such equations, a numerical solution is worked out. Subsequent correlation shows that the resistive model is a good approximation for amplitudes, but cannot account for a variation of phase with amplitude that is indicated

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by the solution of the limiter equations. A revised model is suggested to take care of the phase distortion. The predictions of this model are shown to be qualitatively correct. Further research in this general field is suggested. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ALTERNATIVE DETECTION OF COCHANNEL FM SIGNALS, by E. J. Baghdady. [1959] [1]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 994, May 1959.

Details of a system designed to facilitate the extraction of the message of the weaker of 2 cochannel FM signals are presented. The system, called feedforward, has been shown to enable a receiver to deliver high-quality reproductions of programs that are carried on 2 independent FM carriers. Reception of the weaker signal is possible even when the carrier frequencies sweep the same frequency band. The system described by Farris (Proc. Inst. Radio Engineers, v. 46: 1876-1877, Nov. 1958) is discussed and explanation of its impracticality pointed out.

1126

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CANONICAL FORMS FOR INFORMATION-LOSSLESS FINITE-STATE LOGICAL MACHINES, by D. A. Huffman. [1959] [11]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at 1959 Internat'l. Symposium on Circuit and Information Theory, Los Angeles, Calif., June 16-18, 1959.

Published in I.R.E. Trans. on Circuit Theory, Suppl., v. CT-6: 41-51, May 1959.

Published in I.R.E. Trans. on Information Theory, Suppl., v. IT-5: 41-51, May 1959.

An important class of finite-state machines transforms input sequences of digits into output sequences in a way such that, after an experiment of any finite length on the machine, its input sequence may be deduced from a knowledge of the corresponding output sequence, its initial and final states, and the set of specifications for the transformations by which the machine produces output sequences from input sequences. These machines

are called "information-lossless." Canonical circuit forms are shown into which any information-lossless machines may be synthesized. The existence of inverses for these circuits is investigated and circuits for their realization are derived. (Contractor's abstract)

1127

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

HOW TO GROW YOUR OWN TREES FROM GIVEN CUT-SET OR TIE-SET MATRICES, by E. A. Guillemin. [17]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at Internat'l. Symposium on Circuit and Information Theory, Los Angeles, Calif., June 16-18, 1959.

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 110-126, May 1959.

The method recognizes that construction of a tree (and hence the pertinent graph) from a given matrix can be done by inspection once the pattern of its growth has been established. To this end it is only necessary that we have a mechanism, applicable to a given cut-set matrix, which sorts out those rows that correspond to the outermost twigs or tips of the tree, for we can then form an abridged cut-set matrix corresponding to what is left of the total graph after the tree tips with their uniquely attached links are pruned away. This remainder again has tips which can be found and eliminated in the same way. Continuation thus reveals the desired growth pattern. Since the method cannot fail to yield a graph if its existence is compatible with the structure of the given matrix, it may be regarded as a constructive test for fulfillment of necessary and sufficient conditions. (Contractor's abstract)

1128

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NONLINEAR SYSTEM CHARACTERIZATION AND OPTIMIZATION, by A. G. Bose. [1959] [11]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at 1959 Internat'l. Symposium on Circuit and Information Theory, Los Angeles, Calif., June 16-18, 1959.

Published in I.R.E. Trans. on Circuit Theory, Suppl., v. CT-6: 30-40, May 1959.

Published in I.R.E. Trans. on Information Theory, Suppl., v. IT-5: 30-40, May 1959.

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Characterization and optimization of nonlinear systems is considered from the function space point of view, and implications of this point of view are discussed. Optimization of nonlinear systems is regarded as the problem of mapping the function space of the past of the input onto a line that corresponds to the amplitude of the filter output. It is shown that a system representation that is orthogonal for all possible inputs results from any mapping that partitions this space into nonoverlapping cells. The complication of solving for optimum systems in terms of measured higher-order statistics is circumvented by formulating the problem so that particular statistical measurements directly yield the optimum systems. (Contractor's abstract)

1129

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A FREQUENCY-DOMAIN THEORY OF PARAMETRIC AMPLIFICATION, by B. J. Leon. June 5, 1959, 52p. incl. diagrs. refs. (Technical rept. no. 354) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) **Unclassified**

In the class of high-frequency amplifiers that are known as parametric amplifiers, varactors, and variable-reactance amplifiers, the active elements are variable-reactance parameters; i.e., inductances or capacitances whose values vary periodically. The power that amplifies the desired signal comes from the source which varies the parameter. A general method of analysis of circuits containing a few decoupled periodic elements in a network of lumped, linear, finite, passive, bilateral, time-invariant elements is presented. For these circuits it is shown that the characteristic frequency-domain equations that define the voltages and currents as functions of the complex frequency are linear difference equations with variable coefficients. A sinusoidally varying capacitance in an arbitrary passive network with steady-state signal excitation is discussed. By using the calculus of finite differences to find exact solutions to the difference equations three fundamental statements concerning parametric amplifier performance are proved: (a) The gain is independent of the phase of the signal relative to the varying parameter except in a degenerate case that can easily be avoided. (b) The passive circuit admittance at idler frequency, the difference between the signal frequency and the frequency of the parameter, is important. A circuit with a zero of admittance at the idler frequency will oscillate regardless of the admittance at the signal frequency. (c) Because of the interaction of the signal and the varying element, high-frequency voltages are produced; but the voltage amplitudes go to zero exponentially as frequency increases, if the varying parameter is positive for all time. The mechanics of finding a solution is discussed. (Contractor's abstract)

1130

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

UNIDIRECTIONAL PARAMAGNETIC AMPLIFIER DESIGN, by M. W. P. Strandberg. June 26, 1959 [14]p. incl. illus. diagrs. refs. (Technical rept. no. 363) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) **Unclassified**

Published in Proc. Inst. Radio Engineers, v. 48: 1307-1320, July 1960.

The radio-frequency parameters and the quantum-mechanical parameters entering into the design of paramagnetic quantum-mechanical amplifiers are described and discussed. The physical and electrical limitations on such parameters as gain-bandwidth product, gain stability, and nonreciprocity are described analytically and with design curves. Two realizations of nonreciprocal amplifiers are described and discussed. In particular, operation of a nonreciprocal amplifier at 9 kmc is described. Explanations for the observed properties of previously reported amplifiers are given, and the steps necessary to achieve high gain-bandwidth product and nonreciprocity with paramagnetic amplifiers are described. (Contractor's abstract)

1131

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ANALYSIS OF SEQUENTIAL DECISIONS (Abstract), by D. M. Green and J. A. Swets. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)1728, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) **Unclassified**

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 834, June 1959.

Data presented previously showed that at least on a macroscopic level, the statistical theory of sequential decision as developed by Wald provides a good description of the behavior of human observers in a sequential detection task. In a sequential decision task the observer makes as many observations as he chooses before deciding whether the sequence of observations arose from noise or from signal plus noise. The data showed the error rates and the mean number of observations preceding a terminal decision to vary appropriately with changes in the values associated with the various decision outcomes. Subsequent analysis of the number of terminal decisions made at each observation stage has suggested a simpler model for the observer's behavior in this task. This model assumes that each

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decision is based upon the information obtained from the last observation, and that 1 alone, rather than upon an integration of the information gained from all of the preceding observations. This simpler model fits most of the data. That is to say, on a microscopic level, the data do not support the Wald model.

1132

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AUTOMATIC RESOLUTION OF SPEECH SPECTRA INTO ELEMENTAL SPECTRA (Abstract), by K. N. Stevens, C. G. Bell and others. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 844, June 1959.

The acoustic output for a given configuration and excitation of the vocal tract during speech production can be described in a relatively compact manner by a transfer function characterized by a reasonably small number of poles and zeros. Thus the spectrum of a speech sound (log amplitude vs frequency) may be considered to be the sum of several elemental spectra, each associated with 1 pole or zero. The spectrum envelope of any vowel, for example, could be approximated reasonably accurately by combinations of spectra drawn from a catalog of 30 to 40 curves that represent simple resonances at a number of different frequencies. A digital computer has been programmed to perform such an approximation on spectra of vowel and some consonant sounds sampled periodically in time. Successive comparisons are made between a particular speech spectrum and spectra constructed from a catalog of elementary curves that are stored in the memory. The computer is programmed to converge rapidly from a 1st approximation of the spectrum based on previous examinations of adjacent samples towards the synthesized spectrum that yields the best fit with the input spectrum, and reads out numbers that identify the particular elemental spectra that are finally selected.

1133

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

AVERAGES OF RESPONSES EVOKED BY TONAL STIMULI IN THE AUDITORY CORTEX OF THE CAT (Abstract), by T. Sandel. [1959] [1]p. (Sponsored

jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer. Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 842, June 1959.

Because of the variability of responses evoked by auditory stimuli in the auditory cortex of the cat, it is difficult, if not impossible, to quantify responses to total stimuli without resorting to techniques which alter the physiological state of the nervous system being studied. Such techniques include the use of deep barbiturate anesthesia and the local application of strychnine at the recording sites in order to potentiate the responses, making them visually detectable. In the present study, a digital computer has been used to average large numbers of responses evoked at various locations on the auditory cortex, without the complications of either deep anesthesia or strychnine. Data obtained using this technique are presented showing the organization of responses to tonal stimuli over the surface of the primary auditory areas of the cortex.

1134

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CUEING AS A DETERMINER OF APPARENT VARIABILITY (Abstract), by E. F. Shipley. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)1728, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])

Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 834, June 1959.

The groupings of correct and of incorrect responses in psychophysical experiments have been attributed to changes in sensitivity. This paper suggests another way of accounting for such data. It is hypothesized that a given trial can offer cues to the nature of the stimulus. The adequacy of the cue is presumably determined by the effective stimulus intensity. Stronger stimuli should provide on the average better cues than weaker stimuli. Also trials on which correct responses are made should offer better cues than do incorrect trials. Thus correct responses should follow correct responses. Data were collected in a 2-alternative forced-choice detection experiment in which a strong and a weak signal were presented at random. The proportion of correct responses was higher following correct responses to the strong signal than following correct responses to the weak signal. This is consistent with the notion that the

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adequacy of the cues on preceding trials influences the probability of a correct response. The opposite results would be expected if only fluctuations in sensitivity are involved since a correct response to a weak signal implies a greater average sensitivity than a correct response to a strong signal.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

ON CERTAIN FORMAL PROPERTIES OF GRAMMARS, by N. Chomsky. [1959] [31]p. incl. refs. (In cooperation with Inst. for Advanced Study, Princeton, N. J.) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221311

Unclassified

Also published in Inform. and Control, v. 2: 137-167, June 1959.

A grammar can be regarded as a device that enumerates the sentences of a language. We study a sequence of restrictions that limit grammars 1st to Turing machines, then to 2 types of system from which a phrase structure description of the generated language can be drawn, and finally to finite state Markov sources (finite automata). These restrictions are shown to be increasingly heavy in the sense that the languages that can be generated by grammars meeting a given restriction constitute a proper subset of those that can be generated by grammars meeting the preceding restriction. Various formulations of phrase structure description are considered, and the source of their excess generative power over finite state sources is investigated in greater detail. (Contractor's abstract)

1136

Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

STIMULUS AND RESPONSE THEORIES OF SIGNAL UNCERTAINTY (Abstract), by J. A. Swets and S. A. Sewall. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)1728, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])

Unclassified

Presented at meeting of the Acoust. Soc. Amer., Ottawa (Canada), May 14-16, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 835, June 1959.

The theory of individual choice behavior developed by Luce and adapted by Shipley finds support in experimental results reported by Pollack at the Chicago meeting for the suggestion that one can account for the decrement

in the detectability of signals in noise that results from uncertainty about the signal frequency without postulating a sensory filtering. Tanner, Swets, and Green had proposed a single-band model and Green had proposed a multiband model to account for the decrement. The former model predicts a larger decrement than the latter. Luce's theory implies that the uncertainty affects the response alternatives rather than the mechanism of observation and, as Shipley has observed, implies in particular that if the observer is informed of the signal frequency after his observation, but before making his response, the decrement will not appear. This paper describes the results of an experiment that provides a direct test of this proposition. The experiment also attempts to distinguish more clearly than heretofore the validity of the 2 predictions concerning the size of the decrement by employing experimental conditions which maximize their difference.

1137

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SYNTHESIS AND PERCEPTION OF NASAL CONSONANTS, by K. Nakata. [1959] [6]p. incl. illus. diagrs. table, refs. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221358

Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 661-666, June 1959.

The generation of nasal consonants can be simulated approximately by a cascade connection of simple electrical tuned circuits excited by a quasi-periodic electrical buzz source. The lowest resonance for nasal consonants is in the vicinity of 200 to 300 cps, and the damping of this resonance is greater than that for the 1st resonance of vowels. A terminal-analog synthesizer and control device have been used to generate a number of synthetic syllables, each consisting of a nasal consonant followed by a vowel, with smooth formant transitions between consonant and vowel portions. Systematic listening tests have shown that the identification of the nasal consonant is determined largely by the frequency position of the 2nd resonance of the nasal portion of the syllable, and thus by the direction and extent of the 2nd formant transition of the vowel, as noted in other studies. The identification of the nasal consonant is also dependent to some extent on the duration of the consonant and transition portions of the syllable. Isolated nasal consonants generated by this procedure can also be identified with reasonable consistency. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

TONOTOPIC ORGANIZATION OF THE CAT AUDITORY CORTEX FOR SOME COMPLEX STIMULI, by N. Y-S. Kiang, and M. H. Goldstein, Jr. [1959] [5]p. incl. illus. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 221255 Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 786-790, June 1959.

There is psychophysical evidence that both spectrum and periodicity of acoustic signals may be cues for pitch judgments. At the level of the auditory nerve, these stimulus characteristics seem to be coded in terms of place and time pattern. Very little is known of their representation at higher levels of the nervous system. Tonotopic organization of the auditory cortex has been demonstrated in anesthetized cats by the evoked strychnine potential technique. In these demonstrations only tonal stimuli were used. We use similar physiological preparations but employ acoustic stimuli that permit independent manipulation of spectrum and periodicity. The results show that the previously reported tonotopic organization is based only upon spectral characteristics of the stimulus. (Contractor's abstract)

1139

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DIPOLE AND QUADRUPOLE MOMENTS OF THE ISOMERIC Hg^{197*} NUCLEUS; ISOMERIC ISOTOPE SHIFT, by A. C. Melissinos and S. P. Davis. [1959] [8]p. incl. illus. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Phys. Rev., v. 115: 130-137, July 1, 1959.

The hyperfine structures of 5 optical lines of 65-hr radioactive Hg^{197} and 25-hr isomeric Hg^{197*} were measured. Radioactive mercury produced by cyclotron bombardment and excited in electrodeless discharge tubes containing as few as 5×10^{12} atoms, free of natural mercury, gave adequate light intensities. The analysis of the hyperfine structure confirmed the magnetic dipole moment and isotope shift of Hg^{197} in its ground state ($I = 1/2$), and gave the following values for Hg^{197*} (based on $I = 13/2$): $\mu_{197*} = -1.04 \pm 0.01 \text{ nm}$;

$Q_{197*} = (1.5 \pm 0.3) \times 10^{-24} \text{ cm}^2$; isotope shift displacement (from Hg^{198} in the 2537A line) $+ 70 \pm 7 \times 10^{-3} \text{ cm}^{-1}$. Thus an isomeric shift of atomic energy levels resulting from the excitation of the nucleus from its ground state $I = 1/2$ to the isomeric state $I = 13/2$ is observed. In the 2537A line of mercury this shift amounts to $-21 \pm 6 \times 10^{-3} \text{ cm}^{-1}$.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PROCESSING NEUROELECTRIC DATA, by W. M. Siebert. July 7, 1959, 121p. incl. diagrs. refs. (Technical rept. no. 351) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 218859 Unclassified

This Technical report primarily attempts to bring together in one place the views that this group (Communications Biophysics Group) has developed over the past half dozen years on processing the electrical data that is recorded from the nervous system. Another motivating influence was the need to clarify divergent views by making an over-all assessment of the techniques that are used in everyday research. The presentation that is given here will permit reference to this monograph instead of having to include lengthy and perhaps not always appropriate discussions of data-processing techniques.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SHORT-TIME MEASUREMENT OF TIME DILATION IN AN EARTH SATELLITE, by R. S. Badessa, R. L. Kent, and J. C. Nowell. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Phys. Rev. Letts., v. 3: 79-80, July 15, 1959.

A description is given of a method for measuring the gravitational red shift postulated by Einstein's theory of relativity. Atomic clocks with stability approaching 10^{-11} , and earth satellites capable of orbiting at altitudes which provide a significant difference in gravitational potential enable this type of experiment to be attempted. A short-time measurement (the interval required to permit the small rate difference of the 2 clocks to accumulate a measurable difference in time) was conducted. Because the instantaneous frequency difference between an oscillator on the earth and an oscillator on a satellite as received on the earth is influenced by the

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variation in path length, a technique consisting of transmitting to the ground a signal which had been precorrected was used. This method is described in some detail. Briefly it consists of cancelling out the 1st order Doppler term by utilizing an oscillator of frequency $2f$ and subtracting from it frequency f' which is the frequency of the signal received at the satellite. This frequency difference is then transmitted to earth and received as f'' . The Doppler term is then cancelled out by means of a power series expansion.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CONTINUOUS NONLINEAR SYSTEMS, by D. A. George. July 24, 1959, 102p. incl. diags. refs. (Technical rept. no. 355) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 246281
Unclassified

A functional representation, which is a generalization of the linear convolution integral, is used to describe continuous nonlinear systems. Emphasis is placed on nonlinear systems composed of linear subsystems with memory, and nonlinear no-memory subsystems. An "Algebra of Systems" is developed to facilitate the description of such combined systems. From this algebraic description, multidimensional system transforms are obtained. These transforms specify the system in much the same manner as 1-dimensional transforms specify linear systems. The system transforms and the transform of the system's input signal are then used to determine the transform of the output signal. Transform theory is also used for determining averages and spectra of the system output when the input is a random signal Gaussianly distributed. Certain theoretical aspects of the functional representation are discussed. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

INFLUENCE OF FLUID MOTION PAST A PLANE BOUNDARY ON SOUND REFLECTION, ABSORPTION, AND TRANSMISSION, by U. Ingard. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142)
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1035-1036, July 1959.

It is shown that the effect of fluid motion past a plane boundary on the reflection and absorption of sound is equivalent to an increase of the normal acoustic impedance of the boundary by a factor $(1 + M \sin \phi)$,

where ϕ is the angle of incidence of the sound wave, and M is the Mach number of the flow velocity component in the incidence-reflection plane of the wave. Similarly, the acoustic energy flux perpendicular to the boundary and the flow is shown to be increased by the same factor. Reflection and transmission coefficients of a thin solid interface between a fluid in motion and 1 at rest are given. Furthermore, some comments on the problem of transmission in ducts are given. For propagation between 2 plane parallel boundaries with the same acoustic admittance, we find, for sufficiently small values of the admittance, that the sound pressure attenuation constant of the fundamental mode is modified approximately by the factors $(1 + M)^{-2}$ and $(1 - M)^{-2}$ for downstream and upstream propagation, where M is the flow Mach number.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOISE GENERATED BY TWO INTERACTING AIR JETS, by U. Ingard and G. C. Maling, Jr. [1959] [3]p. incl. diags. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and Wright Air Development Center under AF 33(616)3307)
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1031-1033, July 1959.

It has been observed that the excess noise generated as a result of the interaction or mixing of 2 small air jets is considerably greater than the noise produced by the individual jets. The "interaction noise" produced by jets that lie in the same plane has been measured for jet intersection angles between 0 and 180°. Similar measurements have been made as a function of jet separation by using 2 jets that intersect at a 90° angle but do not lie in the same plane.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SIMPLE EXAMPLES OF MAGNETOMECHANICAL WAVE MOTION, by U. Ingard. [1959] [2]p. incl. diags. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142)
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1033-1034, July 1959.

The phase velocity on a periodic line consisting of coupled mass elements (coils) in a magnetic field is shown to be analogous to the phase velocity of a

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transverse Alfvén wave in a conducting, incompressible fluid. As another example of the magnetomechanics of a simple "distributed" system, the motion of a conducting string in a magnetic field is discussed.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOUND TRANSMISSION THROUGH A VELOCITY DISCONTINUITY, by P. Gottlieb. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1036-1037, July 1959.

The attenuation of a sound wave in a steady flow, with the flow gradient normal to the flow lines, is approximated by 3 different methods. The 1st method approximates the steady flow by layers of constant velocity and applies the boundary conditions of Ribner at each interface. The 2nd method uses the analytic solution for the continuous flow. The last method is similar to the 1st but uses the boundary conditions of earlier authors. It is found that the 1st and 2nd methods give the same answer, and this answer disagrees with that obtained by the 3rd method.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CONNECTIVITY IN PROBABILISTIC GRAPHS, by I. M. Jacobs. Sept. 15, 1959, 62p. incl. diagrs. tables, refs. (Technical rept. no. 356) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 238476 Unclassified

A probabilistic graph is a linear graph in which both nodes and links are subject to random erasure. Such a graph is an idealized model of a communication network in which switching centers (nodes) and information channels (links) either operate perfectly or fail entirely. The reliability of the communication network is considered. Two reliability criteria are established: (1) the probability that a path exists between all pairs of nodes that remain in the associated probabilistic graph after erasure, and (2) the probability that a path exists between one pair of nodes selected at random. For small communication networks, the interesting questions concern analysis (the calculation of the reliability of a given network) and synthesis (the construction, under certain constraints, of graphs with max reliability). For large communication networks, the emphasis is on the link-to-node densities necessary and sufficient for attaining a desired reliability.

The sufficient densities are determined by approx analysis of several graph configurations. The reliability (under the first reliability criterion) is shown to approach 1 exponentially with the decrease in the difference between the link-to-node density and a constant times the logarithm of the number of nodes. This constant is a function of the graph and of the link and node reliabilities. The average reliability of graphs chosen randomly by 2 different procedures is also determined. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NEW DEVELOPMENTS IN FM RECEPTION AND THEIR APPLICATION TO THE REALIZATION OF A SYSTEM OF "POWER-DIVISION" MULTIPLEXING, by E. J. Baghdady. [1959] [15]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research and Signal Corps under [DA 36-039-sc-78108]) AD 241170 Unclassified

Also published in I.R.E. Trans. on Communications Systems, v. CS-7: 147-161, Sept. 1959.

Two techniques--feedforward across a limiter and dynamic trapping--are described to show how the message carried by the weaker of 2 cochannel FM signals can be extracted with negligible distortion even when its amplitude is much smaller than that of the stronger signal. The development of these techniques marks the end of the stronger-signal capture limitation of FM systems and ushers in more efficient spectrum utilization, as well as new applications for frequency modulation. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

QUADRUPOLE SELECTION RULE IN IRON GROUP SPIN-PHONON INTERACTIONS, by R. D. Mattuck and M. W. P. Strandberg. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Phys. Rev. Ltrs., v. 3: 369-370, Oct. 15, 1959.

This report points out the fact that spin-phonon transitions in non S-state iron-group paramagnets obey quadrupole selection rules. This means that for odd half-integer spin systems of $S > 1/2$, the direct spin-phonon transition is approximately forbidden between any pair of spin states, $|1\rangle$, $|2\rangle$, of the form $|1\rangle = a|m_g\rangle + b|-m_g\rangle$, $|2\rangle = c|m_g\rangle + d|-m_g\rangle$, $\langle 1|2\rangle = 0$. Accordingly, it should be impossible to observe acoustic

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saturation of low-frequency ($\sim 10^7$ cps) paramagnetic-resonance signals within Kramers doublets in a spin-3/2 system. It is possible to predict that, in a micro-wave acoustic experiment, a radical decrease in phonon attenuation when H becomes parallel to the crystal optic axis can be seen. It is noted that examination of the existing data on gain-bandwidth product in ruby masers that amplify between nearly pure, and more strongly mixed, $\pm 1/2$ levels, would be desirable in order to compare the compatibility of these data with the selection rule outlined here.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PHYSICS LABORATORY ADMINISTRATION AND OPERATION, by M. W. P. Strandberg. [1959] [5]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Amer. Jour. Phys., v. 27: 503-507, Oct. 1959.

Laboratory instruction in undergraduate courses allows the student to encounter physical problems in association with physicists. The value of this experience does not derive from the experiments per se, but the administration and operation of the laboratory may be arranged to optimize its educational value. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SPHERICAL WAVES OF FINITE AMPLITUDE, by R. D. Fay. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research and Signal Corps under [DA 36-039-sc-78108], and Office of Naval Research under Nonr-184142) Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 1377-1379, Oct. 1959.

A method is presented for the analysis of spherical waves of finite amplitude. An example of the application of the method is given for the case of repeated shock waves.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

STRONG COUPLING IN NUCLEAR RESONANCE SPECTRA. II. FIELD DEPENDENCE OF SOME UNSYMMETRICAL THREE-SPIN SPECTRA, by R. W.

Fessenden and J. S. Waugh. [1959] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Organic Chem. Div. of the Amer. Chem. Soc., New York, N. Y., Sept. 8-13, 1957.

Abstract published in 132nd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1957, p. 72. (Title varies)

Published in Jour. Chem. Phys., v. 31: 996-1001, Oct. 1959.

Magnetic resonance spectra are calculated and compared with experiment for the vinyl group of styrene, 2,4-dichloroaniline, and 2,5-dichloroaniline at various magnetic field strengths. Some simple rules are presented which facilitate the determination of chemical shifts and coupling constants, including the signs of the latter. One of the spectra illustrates the occasional necessity for experiments at more than 1 field strength if the parameters are to be determined unambiguously. In each case the shielding and coupling constants are found to be field-independent within experimental accuracy. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

NOISE MEASUREMENTS ON ELECTRON BEAMS AT 3000 MC, by A. Zacharias and L. D. Smullin. Nov. 12, 1959, 23p. incl. diagrs. tables, refs. (Technical rept. no. 358) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108) AD 240122 Unclassified

Noise measurements were made in a demountable system, on the electron beam produced by a new type of low-noise electron gun. The purpose of the investigation was to determine the effect of the dc electric field at the cathode on Haus' noise parameters S and II. The noise parameter S was found to be significantly influenced by the shape of the electric field in the vicinity of the cathode. Variation of S by a factor of 2 was observed at constant beam current, and by a factor of 4.5 when the beam current was changed. Measured values for II/S were small, the largest being 0.16. The value of II/S was generally not found to be greatly affected by variations in the electric field at the cathode surface. However, a significantly large negative value of II/S was produced by a field configuration that caused higher than normal cathode current density. Agreement was not found between the noise figures predicted from a min-noise-figure equation, and the noise figures observed in traveling-wave tubes that use this type of electron gun. The measured values of S and II predict a beam noisiness of approx 3.5 times that observed in carefully processed, sealed-off tubes. The oxide-cathode coating resistance is proposed as a possible cause

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for this increased noisiness. Contaminants present in the vacuum of the measuring apparatus probably increased the coating resistance by decreasing the cathode activation. Data on coating resistivity, at frequencies near 3000 mc, were used to calculate the effect of cathode resistance on beam noise. The effect appears to be significant. The effect of cathode temperature on the noise parameters was examined. It was found that S was increased by nearly a factor of 2 by an increase of cathode temperature of 80°C (approx 10%), while the value of Π/S remained unchanged. (Contractor's abstract)

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

BARRIER TO ROTATION ABOUT THE METAL-CYCLOPENTADIENYL BCND, by J. S. Waugh, J. H. Loehlin and others. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], Alfred P. Sloan Foundation, and National Science Foundation) AD 248835
Unclassified

Published in Jour. Chem. Phys., v. 31: 1434-1435, Nov. 1959.

The proton resonance of bis-(cyclopentadienyl)molybdenum tricarbonyl $[C_p Mo(CO)_3]_2$, has been examined between 77°K and room temperature. A graph showing the variation of ΔH_2^2 with temperature is given. The results at low temperatures are in agreement with calculations for a rigid lattice, but in view of the difficulties encountered at these temperatures, approximations have been made.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FORMANT TRACKING BY COMPUTER (Abstract), by C. G. Bell, F. Poza, and K. N. Stevens. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1563, Nov. 1959.

A method of formant tracking using a digital computer was described previously. By this method synthetic speech spectra, constructed within the computer from

a catalog of elemental spectra, are compared with measured spectra of a speech signal. The present paper discusses the evaluation, extension, and refinement of this method of analysis. Computer techniques which result in the display of a "synthetic sonagram" are described, together with examples of the use of the computer oscilloscope for displaying intermediate steps in the spectral matching process. Results obtained with a variety of speakers are presented. The problems of preparing a representative catalog of glottal spectra, evaluating the role of analyzing filter banks, and determining a meaningful "fit criterion" are considered. A method similar to the foregoing for synthesizing fricative spectra is also described.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FRICATIVE PRODUCTION BY A DYNAMIC ANALOG SYNTHESIZER (Abstract), by G. Rosen. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1564, Nov. 1959.

Two series of formal listening tests were conducted with fricative consonants generated by a dynamic analog of the vocal tract. The consonants were generated using a fricative configuration consisting of a uniform tube with a single constriction and were presented in CV context, always with the vowel /a/. The variables studied in the 1st test series were the place and degree of constriction and the position of excitation relative to the constriction. Listeners were required to make 1 of 6 fricative responses in forced and nonforced tests. Responses of /s, f/ better than 95% were obtained for some stimuli. The 2nd series of tests was made to determine how closely the temporal relations between articulatory change and buzz and noise excitation need to be specified. Stimuli were presented in pairs and subjects were asked to vote for more "natural" stimulus in each pair. A supplementary identification test showed a sharp change of response from voiceless to voiced fricative as buzz excitation was initiated at progressively earlier times.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

GRADUATE EXAMINATIONS IN PHYSICS, by M. W. P. Strandberg and B. V. Gokhale. [1959] [6]p. incl. diagrs.

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tables. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Amer. Jour. Phys., v. 27: 539-544, Nov. 1959.

The extensive and intensive character and the number of graduate level examinations for doctoral candidates in physics are discussed in relation to the probable objectives which the examinations are intended to serve. Results of a recent survey of graduate examination procedures in universities in the United States are presented. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

HYPERFINE STRUCTURE OF THALLIUM²⁰³ AND THALLIUM²⁰⁵ IN THE $7^2S_{1/2}$ STATE, by R. J. Hull and H. H. Stroke. [1959] [2]p. incl. illus. diags. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Jour. Opt. Soc. Amer., v. 49: 1088-1089, Nov. 1959.

The hyperfine-structure separations of Tl^{203} and Tl^{205} in the $7^2S_{1/2}$ state were obtained from the 3776-A resonance line with a grating spectrograph. These measurements were carried out because previously quoted values resulted from a study of the 5350-A transition ending on the $6^2P_{3/2}$ state, the hyperfine structure of which was inferred to be 8 mk, while recent atomic-beam magnetic-resonance experiments showed $\Delta\nu(6^2P_{3/2}) \approx 17$ mk. Our results for $\Delta\nu(7^2S_{1/2})$ are 405 \pm 5 mk and 412 \pm 4 mk for Tl^{203} and Tl^{205} . (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

PSYCHOACOUSTIC STUDY OF THE MECHANISM OF BINAURAL FUSION (Abstract), by J. L. Hall. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1584, Nov. 1959.

The effect of masking noise on binaural interaction of disparate stimuli was studied. Stimuli were trains of pulses and trains of clicks. With continuous noise added monaurally to noise bursts, more noise was required to prevent fusion when the stimulus in the opposite ear was a noise burst than when it was a pulse. In neither case did the level of noise necessary to prevent fusion make the noise burst inaudible. In fusion of noise bursts and pulses, the level of noise added to pulses necessary to prevent fusion equalled the level which made the pulses undetectible. In another experiment, subjects were presented with trains of single pulses at one ear and closely-spaced pairs of pulses at the other. They were required to fuse the single pulse with the 2nd of the pair of pulses. It was found that the addition of noise to the pair of pulses reduced the minimum interpulse interval at which this was possible. These results are interpreted in terms of a mechanism of binaural fusion which compares the strength of the short-term integrated neural response from the 2 sides. This model receives support from previous electrophysiological observations.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

SOME CHARACTERISTICS OF STOP CONSONANTS (Abstract), by O. Fujimura. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)2061, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and National Science Foundation) Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1568, Nov. 1959.

Stop-vowel syllables were synthesized by use of both the cascaded resonant circuit (POVO) and the dynamical vocal tract analog (DAVO). Variation of formant positions or of articulatory configurations, intensity envelope, and inflection of fundamental frequency were controlled. A noise source was used as excitation for unvoiced stop consonants. Unvoiced stops generated by DAVO are much superior to those generated by POVO when a noise source is inserted at the constriction point of the vocal tract. In comparing utterances produced by POVO with those produced by DAVO some interesting differences have been found. These will be discussed and an explanation will be offered. Methods involving both absolute judgments and paired comparisons have been used.

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Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

STRONG COUPLING IN NUCLEAR RESONANCE SPECTRA. III. SYSTEMS CONTAINING MANY EQUIVALENT SPINS, by J. S. Waugh and F. W. Dobbs. [1959] [5]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108], and National Science Foundation) AD 248850 Unclassified

Published in Jour. Chem. Phys., v. 31: 1235-1239, Nov. 1959.

The spin-coupling problem is discussed for systems of $p + q$ nuclei falling into 2 groups $A_p B_q$ where all members of a group are magnetically equivalent. The energies are given explicitly for $p = 1$, arbitrary q , and formulas are given from which the transition intensities can be computed for this case. The results are applied to the proton resonance spectrum of isobutane ($p = 1, q = 9$), with the results $\delta_{CH_3} - \delta_{CH} = 0.85$ ppm, $A_{CH-CH_3} = 6.8$ cps. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

INCOHERENT MICROWAVE RADIATION FROM PLASMAS, by G. Bekefi, J. L. Hirshfield, and S. C. Brown. [1959] [6]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Phys. Rev., v. 116: 1051-1056, Dec. 1, 1959.

A study is made of the incoherent radiation from an isotropic, quiescent plasma of a low degree of ionization. Three cases are treated theoretically. the transparent plasma, the semiopaque plasma, and the opaque. Radiation from positive columns of dc glow discharges in helium and hydrogen for the 3 cases treated theoretically are studied experimentally at 3000 mc/sec, and good agreement is obtained between theory and experiment. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

LARGE-SAMPLE SEQUENTIAL DECISION THEORY, by E. M. Hofstetter. Dec. 9, 1959, 35p. refs. (Technical rept. no. 359) (Sponsored jointly by Air Force

Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108)
AD 235160 Unclassified

Statistical decision theory represents the latest attempt on the part of the statistician to formulate a general theory of experiment design. The theory allows for sequential experimentation, multivalued terminal decisions, and the use of several different types of experiment. This investigation is devoted to the development of a large-sample theory of experiment design. The main achievements of this theory are a limit theorem that describes the asymptotic behavior of the optimum experiment, and a specific experiment design that realizes this behavior. The theory sheds light on the behavior of sequential procedures, in general, and should prove useful in the solution of problems other than the specific one that is considered. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

EVIDENCE THAT CUT OPTIC NERVE FIBERS IN A FROG REGENERATE TO THEIR PROPER PLACES IN THE TECTUM, by H. R. Maturana, J. Y. Lettvin and others. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 241219 Unclassified

Also published in Science, v. 130: 1709-1710, Dec. 11, 1959.

The frog's retina projects into the superficial neuropil of the opposite tectum in 4 functionally different layers of terminals. Each layer displays a continuous map of the retina in terms of its particular function. The 4 maps are in register. The 4th-dimensional order is reconstituted after section and regeneration of the optic fibers. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of
Electronics, Cambridge.

SATURATION OF PARAMAGNETIC SPINS BY 13-MC/SEC ULTRASONIC PHONONS, by R. D. Mattuck and M. W. P. Strandberg. [1959] [2]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Phys. Rev. Ltrs., v. 3: 550-551, Dec. 15, 1959.

Experiments designed to saturate spin populations in various paramagnets through the use of 13-mc/sec sound waves are discussed. The differences in energy level population were monitored by paramagnetic

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resonance equipment that included a Pound-Watkins oscillator followed by a narrow-band amplifier and a phase-sensitive detector, with dc and 50-cps modulating fields provided by Helmholtz coils. The 1st experiment, performed on ruby having a linewidth of 40 mc/sec gave a acoustic saturation value of $S/S_0 = 1 \pm 0.01$

which is in agreement with theory within the accuracy of the experiment. With Cr^{+++} -doped MgO , however, $S/S_0 \sim 1/2$, which is 10^7 times smaller than theory predicts, and the bandwidth is too large. It is thought that a possible explanation of the Cr^{+++} anomalies may lie in the fact that the Cr^{+++} ion distorts the local lattice considerably. An apparent saturation was observed in a crystal of Brazilian quartz which had been given a 1.4×10^7 -rad dose of γ rays in a Co^{60} source. The bandwidth effect was greater than 176 mc/sec. The approximate frequency independence of the effect suggests that the phonons simply cause thermal heating of the crystal. If this is so, an even greater saturation should be seen in irradiated quartz, but it is pointed out that this postulate seems non-tenable.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

FREQUENCY MULTIPLICATION WITH NONLINEAR CAPACITORS — A CIRCUIT ANALYSIS, by D. B. Leeson and S. Weinreb. [1959] [9]p. incl. diags. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 2076-2084, Dec. 1959.

This paper presents a circuit analysis of frequency multipliers employing nonlinear capacitors. The analysis applies to the case of a multiplier of any order using semiconductor nonlinear capacitors, and specifies impedance levels, power capabilities, and efficiency in terms of the characteristics of the nonlinear element and the associated linear network. From the formulas derived it is possible to specify the optimum nonlinear characteristic for a given circuit and harmonic number, and to calculate the conditions for maximum efficiency. The procedure is also applicable to frequency dividers, and to frequency multipliers employing nonlinear inductance. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

ON THE RESPONSE OF A LINEAR SYSTEM TO AN FM SIGNAL, by E. J. Baghdady. [1959] [2]p. (Sponsored

jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108] Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 387-388, Dec. 1959.

A reply is made to Dr. F. L. H. M. Stumpers criticism concerning his disagreement with an assumption used in an earlier paper (MIT.12:263, Vol. II). The original presentation is repeated with an extensive explanation of its use. Particular emphasis is placed on the conditions which must exist in order for the assumption to be considered valid.

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Massachusetts Inst. of Tech. [Research Lab. of Electronics, Cambridge.

AN APPROACH TO MICROMINIATURE PRINTED SYSTEMS, by D. A. Buck and K. R. Shoulders. [1959] 5p. incl. illus. refs. (In cooperation with Stanford Research Inst., Menlo Park, Calif.) [Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108] AD 248834 Unclassified

A possible process for producing etched wiring on a $0.1\text{-}\mu$ scale is proposed. On the wires of a 200-mesh electron microscope specimen screen was deposited a Parlodion film, and on the Parlodion film was deposited a SiO film. A Mo film of about 800A was deposited onto the SiO film in a vacuum system. The vacuum system was opened and a 400-mesh Cu specimen screen was placed up against the the Mo film. The vacuum system was again pumped down, and after admitting a small amount of tetraethoxysilane, a 1200-v electron flood beam 1 ma/sq cm in current density was turned on for 1 min. The vacuum system was opened, the 400-mesh screen removed, and the vacuum system closed again and pumped down. The substrate was heated to $300^\circ C$ and Cl was admitted to the vacuum system. After 1 min, the screen was placed in the electron microscope, and the Mo film was seen to be cut up into squares about 0.001 in. on a side. The resolution is estimated to be finer than 1μ . (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

CIRCUIT THEORY OF LINEAR NOISY NETWORKS, by H. A. Haus and R. B. Adler. New York, M.I.T. Technology Press and Wiley and Sons, 1959, 79p. incl. diags. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 2 174 Unclassified

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This is 1 in a series of monographs published in an attempt to fill the need for systematic publication of research studies larger in scope than a journal article but less ambitious than a finished book. The principal motivation for this particular work arose from the desire to find a single quantity to describe the noise performance of a 2-terminal-pair amplifier. This quantity, or tag so to speak, is uniquely characterized by 2 features: (1) It clears up questions of the noise performance of low-gain amplifiers or of effect upon noise performance of degenerative feedback; (2) It provides for the 1st time a systematic treatment of the noise performance of negative-resistance amplifiers. It is also shown that the canonical form summarizes in a clear, almost visual manner the connection between the internal noise of a network at any particular frequency and its (resistive, positive, or negative) part.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A UNIDIRECTIONAL, NONRECIPROCAL, SOLID-STATE AMPLIFIER (Abstract), by M. W. P. Strandberg. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108])

Unclassified

The usual methods of instrumentation for a solid-state amplifier for unidirectional operation involve the use of a ferrite circulator or of a double-arm Magic-Tee bridge to decouple input from output. The circulator realization is impossible in some frequency ranges for which circulators are not available. The stabilization and equalization of the gains of 2 paramagnetic amplifiers, which is necessary in the negative resistance bridge to achieve unidirectional operation, is too tricky to be technically desirable. In paramagnetic or ferrimagnetic systems, in which the transition selection rules are strongly controlled by the sign of the circular polarization of the electromagnetic field, unidirectional gain, as well as nonreciprocal gain, can be obtained. The objection to using a circular polarization amplifier arises mainly from the difficulty of establishing a circular polarization field. The prototype work was carried out at x-band but is readily adaptable to other frequencies, to L-band, for example. The coaxial transmission line realization of a circular polarization amplifier results in a stable and large gain-bandwidth product amplifier with low noise figure and moderate size. Furthermore, these principles, since they allow the amplifier to act as its own circulator, obviate the development of both amplifier and circulator for each new operating frequency.

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

COMMUNICATION USING EARTH SATELLITES, by J. B. Wiesner. [1959] [7]p. Incl. illus. table. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 241220

Unclassified

Also published in I.R.E. Trans. on Military Electronics, v. MIL-4: 52-58, Jan. 1960.

A review of the use of earth satellites for reliable, ionospheric-independent communication circuits includes considerations of losses in the propagating path, directivity features, and influences such as Doppler shift. The effects of such influences on bandwidth and range are illuminated. (Contractor's abstract)

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Massachusetts Inst. of Tech. [Research Lab. of Electronics] Cambridge.

CORD CELLS RESPONDING TO TOUCH, DAMAGE, AND TEMPERATURE OF SKIN, by P. D. Wall. [1959] [14]p. Incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]; Bell Telephone Labs. Inc., Public Health Service, and Teagle Foundation) AD 241214

Unclassified

Also published in Jour. Neurophysiol., v. 23: 197-210, Mar. 1960.

Primary afferent neurons of skin and the cells on which they end in the spinal cord have been studied in spinal cats with intracellular microelectrodes. The results concerning afferent fibers are as follows: (1) Single fibers that respond to light touch on the skin of the leg innervate a contiguous area of skin with an oval shape averaging 5 x 4 mm. (2) Pressure-sensitive A fibers form a continuous group within which the threshold varies with fiber diameter. As the fiber diameter decreases within the single group, the threshold for a pressure stimulus increases, and the rate of adaptation to a maintained stimulus decreases. (3) The pattern of discharge in a single fiber is fixed by the intensity and duration of the stimulus, and by the position of the stimulus within the sensitive area. (4) Some of the smaller fibers respond both to pressure and to temperature changes of the skin. Primary central cells results are as follows: (1) Cells that respond to light touch are arranged in a definite lamina in the dorsal part of the dorsal horn. Within this lamina there is a topographic organization, with the peripheral part of the leg medial and the proximal part lateral. (2) Each central cell responds to light touch in a contiguous oval area of skin with an average size of 63 x 32 mm. (3) The afferent fiber projection shows no signs of a subliminal

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fringe, and so the peripheral area subserved by a single cell is unaffected by post-tetanic potentiation, strychnine, asphyxia, small doses of barbiturate or temperature changes. (4) The afferent fibers converging onto a single cell run together in a small microbundle in the dorsal root. Each dorsal rootlet contains many such microbundles from different parts of the leg. (5) All cells that respond briefly to light touch also respond with a prolonged discharge to heavy pressure. (6) All cells that respond to light touch also respond to temperature changes of the skin. (7) It is suggested that fibers of many different diameters converge onto these cells so that they respond to all modalities of skin sensation, but differences in the pattern of discharge depend on the nature of the stimulus. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A STATISTICAL MODEL FOR INTERPRETING NEUROELECTRIC RESPONSES, by M. H. Goldstein, Jr. [1959] 17p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 241138 Unclassified

Also published in Inform. and Control, v. 3: 1-17, Mar. 1960.

Neuroelectric activity recorded after presentation of a controlled stimulus is called an evoked response. Evoked responses are random, in that repeated presentations of a stimulus do not produce identical responses despite all effort to maintain identical conditions for all stimulus presentations. Responses may then be described statistically. The present model attempts to relate statistical characteristics of evoked responses, recorded by gross electrodes, to the statistical activity of the neural elements that contribute to the responses. The model postulates 1 or more populations of elements which, when they fire, contribute elemental waveforms to a gross response in which these waveforms are linearly summed. The statistical behavior of the elements in a population is described by their instantaneous firing rate, which is a function of time. In terms of the model, the statistical properties of the gross response (such as the mean and variance, both of which are functions of time) are shown to be related in a simple way to the instantaneous firing rates and elemental waveforms of the populations that contribute to the response. The model is an extension of the shot-noise model to time-variant phenomena; but some of the assumptions of the shot-noise model (specifically, statistical independence of firings) are relaxed. (Contractor's abstract)

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Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

A METHOD OF EVALUATING DIFFUSION COEFFICIENTS IN CRYSTALS, by O. P. Manley. [1959] [7]p. (Sponsored jointly by Air Force Cambridge Research Center under AF 33(616)3984, Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under DA 36-039-sc-78108, and Office of Naval Research under Nonr-154151) AD 248123

Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 13: 244-250, June 1960.

The mechanism of diffusion is reconsidered with the aid of an extension of Kac's theorem. The analysis yields an activation energy which is simply related to the minimal local deformation energy. It is also found that in contrast with Rice's treatment, the activation energy may be calculated directly from the atomic force constants without resorting to normal mode analysis. (Contractor's abstract)

1175

Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge.

DESIGN AND OPERATION OF A MOLECULAR OSCILLATOR, by H. G. Venkates and M. W. P. Strandberg. [1959] [15]p. incl. illus. refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [DA 36-039-sc-78108]) AD 241724 Unclassified

Also published in Proc. Indian Acad. Sci., v. 51: 123-136, 1960.

Theoretical applications of the design of a 2-level maser of the molecular-beam type are presented. The design and operation of a microwave maser that employs a beam of ammonia molecules are described. (Contractor's abstract)

1176

Massachusetts U. Dept. of Chemistry, Amherst.

OXIDATIVE REACTIONS OF HYDRAZINES. V. SYNTHESIS OF 1,1-DISUBSTITUTED HYDRAZINES AND THEIR SULFONYL DERIVATIVES, by L. A. Carpino, A. A. Santilli, and R. W. Murray. [1959] 13p. incl. refs. (AFOSR-TN-59-284) (AF 18(603)114) AD 212917; PB 140221 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2728-2731, June 5, 1960. (Title varies)

A series of 1,1-disubstituted hydrazines were prepared

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by standard methods which involve nitrosation of the secondary amine and subsequent reduction of the N-nitroso compound by means of Zn-AcOH, Na-EtOH, or LiAlH₄. In 1 case, an N-nitramine (N-nitropiperidine) was substituted advantageously for the corresponding nitrosamine by LiAlH₄ reduction. 1-Butyl, 1-tert-butyl, and 1-allyl-1-benzyl-hydrazine were prepared by benzylation of the primary amine, nitrosation, and reduction. 1-Benzyl-1-benzoylhydrazine was prepared by benzylation of tert-butyl-2-benzylcarbazate followed by the removal of the carbo-tert-butoxy group.

1177

Massachusetts U. Dept. of Chemistry, Amherst.

O-ACYLHYDROXYLAMINES. II. REACTION OF DI-BENZYLAMINE WITH O-MESITOYLHYDROXYLAMINE, by L. A. Carpino. [1959] 3p. (AFOSR-TN-59-285) (AF 18(603)114) AD 212918; PB 140220

Unclassified

Conversion of O-mesitylhydroxylamine to 1, 1-dibenzylhydrazine. A mixture of 5.3 g of crude, freshly prepared O-mesitylhydroxylamine and 17.5 g of dibenzylamine became warm spontaneously and a solid separated after 10-15 min. The mixture was then heated in a water bath at 70-75° for 15 min and treated with 10 ml of H₂O, 15 ml of acetic acid and 3.5 g of benzaldehyde. The resulting mixture was heated in the water bath at 70-75° for 15 min, 250 ml of water added and then extracted with 4 25-ml portions of ether. The ether extracts were washed with water, 10% sodium hydroxide solution and dilute sodium bisulfite solution. Removal of the solvent gave 6.2 g (70%) of the benzal derivative, mp 77-79°. Recrystallization from 80-90° ligroin gave 5.1 g (57.5%) of faintly yellow crystals, mp 81-83°. (Contractor's abstract)

1178

Massachusetts U. Dept. of Chemistry, Amherst.

O-ACYLHYDROXYLAMINES. II. O-MESITYLENE-SULFONYL-, O-p-TOLUENESULFONYL- AND O-MESITOYLHYDROXYLAMINE, by L. A. Carpino. [1959] 11p. Incl. table, refs. (AFOSR-TN-59-1242) (AF 18(603)114) AD 230298; PB 144962 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 3133-3135, June 20, 1960.

O-Mesitylenesulfonyl- and O-p-toluenesulfonylhydroxylamine was prepared by the hydrofluoric acid and perchloric acid cleavages of the corresponding t-butyl N-arenesulfonyloxycarbamates. The structures of the O-arenesulfonylhydroxylamines were established by (a) lodometric analysis, (b) reaction with acetone which

gave the corresponding O-sulfonylacetoximes and (c) infrared examination. O-Mesitylhydroxylamine was prepared similarly from t-butyl N-mesityloxycarbamate. Reaction of O-mesitylhydroxylamine with dibenzylamine gave 1,1-dibenzylhydrazine. (Contractor's abstract)

1179

Materials Research Corp., Yonkers, N. Y.

TRAVEL REPORT TO RUSSIA AND CAMBRIDGE U., CAVENDISH LAB. (GT. BRIT.) (Unclassified title), by S. Weinig. [1959] 6p. (MRC rept. no. 131) (AF 49-638)572 Confidential

1180

[Maudsley Hospital] London (Gt. Brit.).

THE RETICULAR FORMATION, STRESS, AND ENDOCRINE ACTIVITY, by G. W. Harris. [1958] [15]p. incl. diagrs. refs. (AF 61(514)953) Unclassified

Published in Proc. Henry Ford Hospital Internat'l. Symposium on Reticular Formation of the Brain, Detroit, Mich. (Mar. 14-16, 1957), Boston, 1958, p. 207-221.

In a review of the gross anatomy and principle functions of the reticular formation, attention is called to specific changes in the pattern of activity of the pituitary and to nonspecific changes in pituitary function (greater secretion of antidiuretic and adrenocorticotrophic hormones and suppressed secretion of thyrotrophic hormones), both of which may be brought about by diverse sources of sensory input. The effect of 24-hr electrical stimulation of the hypothalamus (supraoptic-hypophyseal tract) upon thyroid function was determined in 43 normal rabbits. Thirty-three showed inhibition or no change, and 10 showed increased thyroid activity. Thirty-two of those showing inhibition or no change were adrenalectomized, where upon the same stimulation showed 13 with inhibition or no change and 19 with varying degrees of increased thyroid activity. Other experiments indicate that implants of stilbestrol di-n. butyrate in the mammillary region of the hypothalamus may result in full sexual behavior in female cats.

1181

Maudsley Hospital, London (Gt. Brit.).

HYPOTHALAMIC MECHANISMS AND THE CONTROL OF SEXUAL BEHAVIOR IN THE FEMALE CAT, by G. W. Harris and R. P. Michael. [1958] [1]p. [AF 61(514)953] Unclassified

Presented at meeting of the Physiol. Soc., London (Gt. Brit.), Mar. 21-22, 1958.

Published in Jour. Physiol., v. 142: 26P, June 18, 1958.

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A method is described by which small amounts of hormone can be directly applied to various sites in the central nervous system. Using ovariectomized female cats, small implants were introduced locally, by means of a stereotaxic technique, into the hypothalamus, thalamus, amygdala, pre-optic area, caudate nucleus and cerebellum. The release rate from solid implants of esters of stilboestrol diminishes with increasing length of the fatty acid side-chain. In experiments employing the dibutyrate ester, 13 of 17 animals with oestrogen applied locally to the posterior hypothalamus showed sustained mating behavior, while only 1 of the 19 animals with implants in other parts of the brain mated, though some showed signs of sexual activity. These findings indicate that the behavioral effects are due to local and not general hormone action and support the conclusion that there exists in this basal area of the brain a mechanism for integrating simpler reflexes into the complex pattern of sexual behavior.

1182

Maudsley Hospital, London (Gt. Brit.).

NEUROENDOCRINE CONTROL OF TSH REGULATION, by G. W. Harris and J. W. Woods. [1959] [21]p. incl. illus. diagrs. refs. (AF 61(514)953) Unclassified

Published in Proc. Internat'l. Symposium on Comparative Endocrinology, Cold Spring Harbor, N. Y. (May 25-29, 1958), New York, Wiley and Sons, 1959, p. 202-222.

Regulation of the thyroid gland secretion is discussed with particular emphasis placed on the factors involved in cold stimulation and stress inhibition of thyroid activity. Evidence is presented to support the suggestion that a cold stimulus excites a nervous reflex, via the hypothalamus, to stimulate the anterior pituitary secretion of TSH. It is shown that the latent period of the thyroid response to a cold stimulus is 1/2-4 hr. The anterior pituitary responds with TSH in less than 1/2 hr to cold stimuli, and the thyroid gland responds to exogenous TSH in 5-30 min. The central nervous system's role in thyroid function is examined. It is shown by responding to emotional stimuli that the c.n.s. must play a part. Thyroid activity is reduced to zero within 3 hr of application of stressful stimuli. This suggests that the inhibition of TSH from the anterior pituitary is by means other than hormonal. The vagus nerve supply to the thyroid is reviewed along with the autonomic innervation of its blood vessels. It is thought that this nerve supply can affect the sensitivity of the thyroid cells to the thyrotropic hormone. The hypothalamic nerve influence is shown by lesions which inhibit the secretion of TSH and localized electrical stimulation which should elicit TSH secretion if the electrodes are properly placed. This is complicated by the fact that ACTH is a thyroid inhibitor. Results here indicate that the TSH secretion can be elicited.

1183

Maudsley Hospital, London (Gt. Brit.).

THE ACUTE EFFECTS OF INJECTION OF THYROTROPIC HORMONE, OR OF ELECTRICAL STIMULATION OF THE HYPOTHALAMUS, ON THYROID ACTIVITY, by H. J. Campbell, R. George, and G. W. Harris. [1959] [2]p. [AF 61(514)3] Unclassified

Presented at meeting of the Phys. al Soc., Cambridge (Gt. Brit.), May 23, 1959.

Published in Jour. Physiol., v. 148: 5P-6P, Oct. 1959.

In order to investigate acute changes in thyroid function, the radioactivity of blood samples taken from the thyroid vein (V) were compared with the radioactivity of arterial blood samples (A). Rabbits, injected with 20-80 μC ^{131}I 48 hr previously, were anesthetized with chloralose and urethane, and fine polythene cannulae inserted into a thyroid vein and a saphenous artery. Small blood samples were collected at 15 min intervals, and the difference in radioactivity of the venous and arterial samples (V-A) measured. The results show that (1) an acute preparation may be satisfactorily used for investigations of factors influencing thyroid function; (2) the thyroid responds rapidly to an increased concentration of TSH in the blood; and (3) electrical stimulation of the region of the supraoptic-hypophyseal tract in the hypothalamus causes an increase in thyroid activity.

1184

Max-Planck-Inst. für Strömungsforschung, Göttingen (Germany).

THE SCATTERING OF SOUND BY A SINGLE VORTEX AND BY TURBULENCE, by E.-A. Müller and K. R. Matschat. Jan. 1959, 50p. incl. diagrs. refs. (AFOSR-TN-59-337) (AF 61(514)1143) AD 213658; PB 140691 Unclassified

The results of the single-vortex theory are applied to scattering by turbulence. The turbulent flow is represented by statistically distributed vortices. Isotropic and extreme nonisotropic turbulence are considered. The total scattering power turns out to be proportional to the 5th or 2nd power of the frequency of the incident sound wave, depending on whether the frequency is low or high.

1185

Méditerranéen de Recherches Thermodynamiques, Nice (France).

USE OF THE REVOLVING ARM METHOD FOR THE DETERMINATION OF THE STAGNATION TEMPERATURE IN AN IONIZED GAS, by F. M. Devienne, A. F.

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Roustan and others. Feb. 1959 [21]p. incl. illus. diags. (AFOSR-TN-59-196) (AF 61(514)1126) AD 211473; PB 139554 Unclassified

The use of the revolving arm method was described with regard to the determination of phenomena which occur during the displacement of a body in an ionized atmosphere. The method enables one to measure the state of ionization of the gas and to study the influence of the displacement velocity of a body on the recombination rate of the ions on the surface of the moving body.

1186

Méditerranéen de Recherches Thermodynamiques, Nice (France).

STUDY OF THE FLOW INSIDE MACH 4 NUMBER NOZZLE IN THE VERY LOW DENSITY WIND TUNNEL, by F. M. Devienne, G. M. Forestier, and J. Souquet. Mar. 1959 [13]p. incl. diags. (AFOSR-TN-59-482) (AF 61(514)1126) AD 215735; PB 142722 Unclassified

Measurements were made in order to study the variations of the static and impact pressures inside the nozzle of the highly rarefied wind tunnel. The measurements indicate that the pressure varies in a continuous manner inside the nozzle and that the different flow regimes (slip-flow, transition and free-molecular) establish themselves gradually. (Contractor's abstract)

1187

Méditerranéen de Recherches Thermodynamiques, Nice (France).

REALISATION OF A MOLECULAR GUN OR COSMIC WIND TUNNEL, by F. M. Devienne. Oct. 1959, 57p. incl. illus. diags. refs. (AFOSR-TN-59-1292) (AF 61(052)296) AD 232218; PB 146134 Unclassified

The building conditions are described of a molecular gun, an apparatus by means of which it is possible to reproduce conditions to which a solid body, moving at a cosmic speed, in a rarefied gas, is submitted. The apparatus is based on the exchange momentum between 2 crossed beams, 1 of these being a molecular beam corresponding to an ordinary temperature, and the other an ion beam in which the ions are accelerated by voltages included between a few volts and a few hundred volts. After having outlined the principles of the apparatus and its different parts, the calculations are given on the probabilities of collision between a high speed ion and a low speed molecule. The means by which a slight dispersion of molecules may be obtained is indicated, so that the paths of the high speed molecules shall not be disturbed as a result of intermolecular collisions. The specifications that the ion beam must comply and in what way the ions and the high speed molecules must be separated are discussed. The possible intensities of the high speed molecular beams, corresponding to a static pressure of $1/10 \mu$

of mercury and to a speed capable of attaining 20 to 30 km/sec are also discussed. Finally, it is indicated how, by means of a special device, the speed of fast moving molecules can be measured. (Contractor's abstract)

1188

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

HELICAL FLOW OF GENERAL FLUIDS, by B. D. Coleman and W. Noll. [1959] [5]p. (AFOSR-TN-59-506) (In cooperation with Carnegie Inst. of Tech., Pittsburgh, Pa.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)541 and National Science Foundation) AD 215931 Unclassified

Also published in Jour. Appl. Phys., v. 30: 1508-1512, Oct. 1959.

The problem of the helical flow of a general fluid is solved making no special constitutive assumptions other than incompressibility. It is shown that from a knowledge of the rheologists' viscosity function one can calculate the dependence of the velocity field in helical flow on the geometry and applied forces. The complete stress distribution (including normal stresses) may be calculated from a knowledge of 3 basic material functions which can, in principle, be determined from an experimental study of simple shearing flow. Expressions are derived for the discharge rate and for the angular velocities of the bounding cylinders as functions of the applied forces. (Contractor's abstract)

1189

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

ON THE THERMOSTATICS OF CONTINUOUS MEDIA, by B. D. Coleman and W. Noll. July 1959, 77p. incl. refs. (AFOSR-TN-59-852) (In cooperation with Carnegie Inst. of Tech., Pittsburgh, Pa.) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)541 and National Science Foundation) AD 225435; PB 144320 Unclassified

Also published in Arch. Rational Mech. and Anal., v. 4: 97-128, 1959.

An attempt is made to develop a rigorous theory of thermostatics for continuous bodies in arbitrary states of strain, deriving some of the fundamental laws of hydrostatics and elastostatics from thermodynamic principles. The theory is based on 2 physical postulates. The 1st asserts that, at a material point, any local thermomechanic state can be an equilibrium state provided the local temperature and local forces have appropriate values. The 2nd postulate is essentially the assumption that, at least in continuum mechanics, absolute temperatures are never negative. From these postulates proof is presented of the relationships between

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the stress-strain equation and the caloric equation of state, and various inequalities restricting the form of the caloric equation of state are derived.

derivatives derived from the correlation field splittings. The possible use of other bases for correlation field splittings is discussed. (Contractor's abstract)

1190

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INTERMOLECULAR INTERACTIONS IN THE SOLID STATE. EXTENT OF FREEDOM OF ROTATIONAL MOTION OF SMALL MOLECULES, by R. M. Hexter and D. E. Milligan. June 1, 1959 [25]p. incl. diagrs. tables, refs. (AFOSR-TN-59-569) (AF 49(638)542) AD 217003 Unclassified

The high resolution spectra in matrix isolation was investigated of H_2O , D_2O , NH_3 , CH_4 , SiH_4 , and GeH_4 using A, N, and GeH_4 as matrices. Spectral measurements were made on NH_3 suspended at great dilution in solid argon ($A/NH_3 = 500-1200$) and nitrogen ($N_2/NH_3 = 500-1700$). A total of 9 lines with widths comparable to those observed in the spectrum of gaseous NH_3 were observed in the $950-1030\text{ cm}^{-1}$ region in the spectrum of NH_3 suspended in solid A. The frequencies of these lines and their relative intensities are given. Lines observed in the spectrum of NH_3 suspended in solid N are also given. The spectral features under consideration correspond to the symmetric bending mode ($\nu_{2,u}$) of NH_3 . The spectrum of gaseous NH_3 in A appears from the table to have only lines in the R branch. Support of the R branches is found in the matrix spectrum of ND_3 in A. Two series are again found, with separation within each of approximately 10 cm^{-1} as in the gas. It appears that the modification of the barrier to inversion imposed by an A matrix becomes gross in a N matrix. The NH_3 molecule is unable to invert in this material.

1191

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INTERMOLECULAR COUPLING OF VIBRATIONS IN MOLECULAR CRYSTALS, by R. M. Hexter. Oct. 22, 1959 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1139) (AF 49(638)542) AD 228614; PB 144867 Unclassified

The theory of Davydov of the origin of correlation field splittings is applied to the non-degenerate modes of solid methyl chloride. Intermolecular coupling constants and dipole derivatives for these modes in the solid are derived. An isotope effect on such splittings is reported for the 1st time in CH_3I and is accounted for by means of Davydov's theory. The effect of intermolecular transition dipole coupling on intensities is derived and compared with implications of the dipole

1192

Mellon Inst. [Dept. of Chemistry] Pittsburgh, Pa.

INFRARED SPECTROSCOPIC EVIDENCE FOR THE ROTATION OF THE AMMONIA MOLECULE IN SOLID ARGON AND NITROGEN, by D. E. Milligan and R. M. Hexter. Dec. 18, 1959 [13]p. incl. diagrs. tables. (AFOSR-TN-59-1327) (AF 49(638)542) AD 230764; PB 144908 Unclassified

Also published in Jour. Chem. Phys., v. 34: 1009-1012, Mar. 1961.

High resolution infrared ammonia spectra of the symmetric bending mode suspended at high dilution in solid argon and nitrogen were obtained. More than a half dozen extremely sharp bands have been observed in the $950-1040\text{ cm}^{-1}$ region in the spectrum of ammonia in these materials under conditions where there should be little if any absorption due to polymeric species. The frequency separations of the bands, their temperature dependence and their extreme sharpness appear to be compatible with a model in which the ammonia molecule executes quantized rotation in these solids. (Contractor's abstract)

1193

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

THE ROLE OF THE STRONG MARKOV PROPERTY IN PROBABILITY THEORY, by D. G. Austin. Sept. 1959 [10]p. incl. refs. [Research rept. no. 11] (AFOSR-TN-59-1035) (AF 49(638)184) AD 231319; PB 145557 Unclassified

Stochastic processes are described which are linked to the strong Markov property and its applications. Markov chains are considered. A sample function property and a version of the strong Markov theorem are also considered for processes with separable metric state space and with no stationarity assumption on the conditional probabilities. (Contractor's abstract)

1194

Miami U. [Dept. of Mathematics] Coral Gables, Fla.

THE GENERALIZED BACKWARD KOLMOGOROV EQUATION IN ABSTRACT FORM, by D. G. Austin. [1959] [6]p. (AFOSR-3274) [AF 49(638)184] Unclassified

Also published in Illinois Jour. Math., v. 3: 532-537, Dec. 1959.

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Let (\mathfrak{J}, X) denote an abstract space X and a Borel field \mathfrak{J} of subsets of X containing X and all 1-point sets, and let $P_t(x, E)$ ($t \geq 0$, $x \in X$, $E \in \mathfrak{J}$) denote a stationary Markov transition function such that $P_t(x, \{x\})$ is \mathfrak{J} -measurable for each t , tends to $P_0(x, \{x\}) (= 1)$ as $t \downarrow 0$ for all x , and has a finite right-hand derivative at $t = 0$ for some one x (x^* , say). Then the derivative $P'_t(x^*, E)$ exists for $t > 0$ and all E in \mathfrak{J} , and $P'_t(x^*, \cdot)$ is an uniformly bounded measure of \mathfrak{J} satisfying $P'_{t+s}(x^*, E) = \int_X P_s(\cdot, E) dP'_t(x^*, \cdot)$. (Math. Rev. abstract)

1195

Miami U. [Dept. of Physics] Coral Gables, Fla.

STUDIES OF IONIZATION PARAMETERS IN NUCLEAR EMULSIONS, by M. Blau, S. C. Bloch and others. Feb. 4, 1959 [31]p. incl. diagrs. refs. (AFOSR-TN-59-229) (AF 49(638)97) AD 211842; PB 140224

Unclassified

Also published in Rev. Scient. Instr., v. 31: 289-297, Mar. 1960.

A semi-automatic instrument for ionization measurements in emulsion is briefly described. The instrument was used in the investigation of the various ionization parameters. Deviations from a purely exponential gap length distribution were observed, a result found earlier by Cortini et al. This observation casts some doubt on the unrestricted use of the mean gap length as a parameter. A new parameter, based on the blob length distribution, and which is useful over the entire ionization range, is proposed. The relation of this parameter to grain density is discussed. It is shown that the behavior of the latter (as determined from the blob length distribution) as a function of restricted ionization loss seems to be in agreement with theoretical expectations, with the exception of the very dense region, where appropriate corrections are proposed.

1196

Miami U. [Dept. of Physics] Coral Gables, Fla.

NEGATIVE PION INTERACTIONS AT $1.3 \frac{\text{BeV}}{C}$, by M. Blau, C. F. Carter, and A. Perlmutter. July 10, 1959 [35]p. incl. diagrs. tables, refs. (AFOSR-TN-59-788) (AF 49(638)97) AD 220514; PB 145040

Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 704-721, Nov. 16, 1959.

A total of 340 m of track of negative pions of momentum $1.3 \frac{\text{beV}}{C}$ have been followed in emulsion, and pion interactions have been recorded. Special emphasis is placed

on inelastic scattering on free protons (single meson production). The resulting angular and momentum distributions of the emitted particles are investigated and compared with previous experiments at similar energies. An attempt is made to explain these results on the basis of an isobar decaying into a nucleon and the slower pion. In the case of reaction $\pi^- + p \rightarrow \pi^- + \pi^0 + p$, it appears that there exists an anisotropy in the isobar frame of reference, in which the slower pion is emitted predominantly backward, with respect to the isobar direction. The results are compared with the $\pi - \pi$ coupling model. Angular and energy distributions of mesons emitted in nuclear interactions are investigated and compared with other results and Monte Carlo calculations. The meson multiplicity and energy degradation in these collisions are also discussed. Strange particles found during the investigation are analyzed. (Contractor's abstract)

1197

Miami U. [Dept. of Physics] Coral Gables, Fla.

ON THE HIGH-TEMPERATURE EXPANSIONS OF THE SUSCEPTIBILITY OF A HEISENBERG FERROMAGNET, by H. [A.] Brown. Final rept. [Oct. 1, 1959] [16]p. incl. diagrs. tables. (AFOSR-TR-59-154) (AF 49(638)630) AD 231828; PB 145663

Unclassified

The work done in correcting the values of a_5 (the 5th-approximation coefficient) for the QL (quadratic layer), SC (simple cubic), and BCC (body-centered cubic) lattices as formerly published (Phys. Rev., v. 104: 624-625, Nov. 1, 1956) is described and the results therein extended to the FCC (face-centered cubic) and HL (hexagonal layer) lattices. The evaluation of a_6 is also begun for these 5 lattices. The error in question was found to have been computed incorrectly and it vanished for spin $1/2$. The counting problem is discussed for $n = 1$ through 6 explaining the number of graphs possible under each condition. A short evaluation of the traces is also given.

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Miami U. [Dept. of Physics] Coral Gables, Fla.

SURFACE STATES IN A FINITE ONE-DIMENSIONAL LATTICE (Abstract), by H. A. Brown. [1959] [1]p. [AF 49(638)630]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 275, Apr. 30, 1959.

Using a method similar to Kramer's treatment of 1-dimensional repetitive potential, a finite 1-dimensional lattice of N atoms is considered. By continuity conditions, the wave function in successive cells is generated by means of a 2×2 matrix, M , whose elements are

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known in terms of the values of the even and odd solutions in 1 cell and their derivatives evaluated at the edge of the atomic cell. For a given potential, these elements are functions of the energy only. The electron probability density in the n th cell is obtained in terms

of the matrix elements of M^n , which is found from a recurrence formula for M , and a surface is defined as 1 for which the probability density increases monotonically away from the center of the lattice. It is then easy to obtain the following results already found by Shockley by means of a somewhat different procedure. As an adiabatic compression from infinite separation is carried out and the atomic levels spread out into bands, no surface states occur until bands cross, after which they occur in pairs for large enough N . Furthermore, the larger the value of N , the closer in energy do the pairs lie.

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Michigan State U., East Lansing.

ON THE CASIMIR OPERATOR, by H. E. Campbell.
[1957] [7]p. [AF 49(638)511] Unclassified

Published in Pacific Jour. Math., v. 7: 1325-1331, 1957.

A new definition of the Casimir operator for associative, Lie and alternative algebras, which keeps desirable properties of the usual Casimir operator and which is useful for arbitrary characteristic is presented. It is shown that under certain conditions the Casimir operator is the identity transformation, and for non-degenerate alternative (or associative) algebras that it is the transformation into which the identity element of the algebra maps. The results are applied to obtain the 1st Whitehead lemma for non-degenerate alternative algebras of arbitrary characteristic. A special case of the Levi theorem for Lie algebras of prime characteristic is also discussed.

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Michigan State U. Dept. of Physics and Astronomy,
East Lansing.

THE BETA DECAY OF K^{40} , by W. H. Kelly, G. B. Beard, and R. A. Peters. July 20, 1959 [7]p. incl. diagrs. refs. (AFOSR-TN-59-75) (AF 49(638)10) AD 209917 Unclassified

Also published in Nuclear Phys., v. 11: 492-498, June 1959.

The beta decay of K^{40} was studied using a 1 in. diam x 1 in. high KI(Tl) scintillation crystal. The Kurie plot of the beta spectrum was made linear down to less than 200 kev by the use of the exact third forbidden correction factor. The uncertainty in the correction for electron escape is suggested as the main source of non-linearity below this energy. The extrapolated end point energy

was 1.35 ± 0.02 mev. A specific activity of 27.2 ± 0.5 betas/sec/g of natural potassium was obtained. This corresponds to a decay constant $\lambda(\beta) = (4.72 \pm 0.09) \times 10^{-10} \text{ y}^{-1}$ and a half-life $t(\beta) = (1.47 \pm 0.03) \times 10^9 \text{ y}$. (Contractor's abstract)

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Michigan State U. [Dept. of Physics and Astronomy]
East Lansing.

BETA DECAY OF Rb^{87} (Abstract), by G. B. Beard and W. H. Kelly. [1959] [1]p. [AF 49(638)10] Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 324, June 18, 1959.

A 1-in. x 3/4 in. NaI(Tl) crystal containing a few tenths % rubidium has been used to investigate the beta activity of Rb^{87} . The scintillation efficiency of the crystal for gamma rays was measured and found to be about 80% of that obtained using a comparison NaI(Tl) crystal grown under the same conditions. For the 662 kev Cs^{137} gamma ray, the resolution of the rubidium doped crystal was 13.6% compared to 12.4% for the undoped crystal. Measurements of the specific activities of small sections taken from the ingot both above and below the mounted crystal volume showed that the rubidium iodide added to the melt did not distribute evenly throughout the ingot. Therefore, a qualitative determination of the rubidium content in the crystal is necessary before the specific activity of the Rb^{87} can be calculated. Preliminary results of this and beta spectrum analysis will be presented.

1202

Michigan State U. [Dept. of Physics and Astronomy]
East Lansing.

NATURAL ALPHA ACTIVITY OF Nd^{144} (Abstract), by W. H. Kelly and G. B. Beard. [1959] [1]p. [AF 49(638)-10] Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 324, June 18, 1959.

The natural alpha activity of Nd^{144} has been measured using a loaded liquid scintillator containing 2% neodymium by weight. Preliminary results give a specific activity of about 4 counts/sec/g of Nd^{144} . This

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corresponds to a Nd^{144} half-life of 2×10^{13} yr. The observed activity could also be accounted for by the presence of about 0.9% samarium as an impurity. However, the neodymium used in the scintillator has been analyzed and found to contain less than 0.01% samarium so that the presence of much samarium impurity is unlikely.

1203

Michigan State U. [Dept. of Physics and Astronomy]
East Lansing.

ELECTRICAL RESISTIVITY OF THIN METALLIC WIRES, by H. G. Satz. July 25, 1959, 1v. incl. diagrs. refs. (AFOSR-TN-59-638) (AF 49(638)70) AD 220470; PB 143671 Unclassified

Measurements by Olsen (Helv. Phys. Acta, v. 31: 713, 1958) on thin indium wires at low temperatures have demonstrated that not only the residual but also the temperature dependent part of the resistivity increases as the wire diam decreases. It was suggested by Olsen that small angle phonon scattering, which may take electrons to the surface, where they suffer diffuse scattering, might give rise to the observed effect. Since an exact solution of the transport equation in this case is beset with nearly insurmountable difficulties, an extremely crude analysis has been resorted to, similar to that employed by Nordheim (Act. Sci. et Ind.) no. 131 [Paris, Hermann]). Two mechanisms are considered: (1) Electron-phonon scattering, which takes electrons to the surface in a time shorter than τ_{ph} , where τ_{ph} is the electron-phonon relaxation time in the bulk; and (2) Electron-electron scattering, which, although of no consequence in the bulk, may also contribute to the resistivity of a thin wire by bringing carriers to the surface. (Contractor's abstract)

1204

Michigan State U. Dept. of Physics [and Astronomy]
East Lansing.

POLARIZATION OF THE Al^{27} NUCLEI IN RUBY, by J. A. Cowen, W. R. Schafer, and R. D. Spence. [1959] [6]p. incl. illus. diagr. (AFOSR-TN-59-263) (AF 49(638)613) AD 217687 Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 13-14, July 1, 1959.

It is found that it is possible to observe either enhanced nuclear absorption or emission signals by driving a microwave transition of the chromium impurity. Results show that with the magnetic field adjusted so that the chromium spin resonance occurs at the low-field end of the magnetic field sweep, all the components of the aluminum nuclear resonance show an enhancement if sufficient microwave power is applied. With the magnetic field adjusted so that the chromium spin res-

onance occurs at the high-field end of the sweep, all of the components of the nuclear resonance give strong emission signals if sufficient microwave power is applied. The enhanced or emission signals build up exponentially with a characteristic time which varies from less than a second to a few seconds depending on the orientation of the crystal.

1205

Michigan U., Ann Arbor.

A STUDY OF INSTABILITY OF THE FLOW AND BOUNDARY LAYER TRANSITION NEAR THE NOSE OF BLUNT BODIES OF REVOLUTION. PART II. A WIND TUNNEL FACILITY FOR BOUNDARY LAYER TRANSITION STUDIES ON A COOLED BLUNT BODY IN SIMULATED HYPERSONIC FLOW, by R. Dunlap and A. M. Kuethe. Final rept. Sept. 1959, 29p. incl. illus. diagrs. refs. (AFOSR-TR-59-144) (AF 49(638)-336) Unclassified

The development of apparatus for an experimental study of the stability of the laminar boundary layer over supercooled blunt bodies under simulated hypersonic flight conditions is described. The method involves hot-wire measurements of the growth of disturbances in the boundary layer on a cooled hemisphere. A shroud around the model is designed to cause the pressure distribution to be identical with that observed in hypersonic flight. The analysis leading to the shroud design is new and given in detail. The apparatus has been constructed and excellent agreement is found between measured and theoretical pressure distributions on the hemisphere. (Contractor's abstract)

1206

Michigan U. Dept. of Chemical and Metallurgical Engineering, Ann Arbor.

THE EFFECTS OF STRAIN ON THE INTERFACIAL ENERGIES OF SOLIDS, by S. Floreen, E. E. Huckle, and D. V. Ragone. Nov. 9, 1959, 15p. incl. tables, refs. (AFOSR-TN-59-1253) [AF 49(638)422] AD 233780; PB 146740 Unclassified

A relationship is developed to show that the surface energy and the grain boundary energy of a solid changes with the elastic strain in the following manner: $\gamma = \gamma_0 + k\epsilon^2$, $\beta = \beta_0 + j\epsilon^2$ where γ and β are the average surface energy and grain boundary energy at strain ϵ , γ_0 and β_0 are the respective energies at zero strain, and j and k are constants. On the basis of elastic properties that have been reported and also of some preliminary tests on metal wires, it is concluded that the order of magnitude of k is 10^8 ergs/cm². The order of magnitude of j is unknown at the present.

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1207

Michigan U. Dept. of Chemical and Metallurgical Engineering, Ann Arbor.

WHISKER GROWTH ON VANADIUM PENTOXIDE SURFACES, by V. J. Lee and G. Parravano. Mar. 1959, 30p. incl. illus. diags. (Rept. no. 2832-1-T) (AFOSR-TN-59-184) (AF 49(638)493) AD 211324; PB 140548
Unclassified

The growth of whiskers has been observed on single crystals and polycrystalline samples of vanadium pentoxide. Detailed data on the growth rate are presented for temperatures 546 to 650° in air, steam and vacuum, for closed and open atm. From the kinetic expressions a growth mechanism has been derived. The mechanism involves gas phase condensation and surface diffusion on the whisker top together with bulk diffusion within the whisker. The interplay of different factors in determining the type of growth is discussed. In open systems, whiskers were found to grow by diffusion from the base, while evaporation was predominant at the top. Whiskers, which upon growing on the surface of a vanadium pentoxide microsphere at uniform cross section, meet a neighboring sphere, grow suddenly in diam. It is suggested that whisker formation represents the first stage of sintering of vanadium pentoxide particles. (Contractor's abstract)

1208

Michigan U. Dept. of Chemical and Metallurgical Engineering, Ann Arbor.

SINTERING OF VANADIUM PENTOXIDE, by G. Parravano and V. J. Lee. June 1959, 6p. incl. diags. (Rept. no. 2832-2-T) (AFOSR-TN-59-481) (AF 49(638)493) AD 215734; PB 142357
Unclassified

The sintering of vanadium pentoxide microspheres has been studied in the temperature range of from 560 to 650°C in air and with spheres of diameters varying from 0.2 to 0.9 mm. Rate data have been interpreted in terms of a sintering mechanism involving migration of vacancies along the surface and grain boundaries of the spheres. The role of whisker growth on sintering is discussed. The overall sintering process is shown to be the result of several steps: the initial stage of the kinetic sequence is the growth of oxide whiskers. (Contractor's abstract)

1209

Michigan U. Dept. of Electrical Engineering, Ann Arbor.

DETECTION OF A SIGNAL SPECIFIED EXACTLY WITH A NOISY STORED REFERENCE SIGNAL, by T. G. Birdsall. Sept. 1959, 22p. incl. diags. table. (Technical rept. no. 93; rept. no. 2803-1-T) (AFOSR-TN-59-909) (AF 49(638)369) AD 229517; PB 144784
Unclassified

This report treats the optimization problem of detecting the presence of a signal in a background of white Gaussian noise, under the restriction that the signal is specified exactly but the receiver memory contains only a noisy version of the signal. The optimum receiver is specified. The performances of both the optimum receiver and the cross-correlation receiver with a noisy memory are calculated and compared for a special case. (Contractor's abstract)

1210

Michigan U. Dept. of Electrical Engineering, Ann Arbor.

LABORATORY FACILITIES EMPLOYED IN PSYCHOPHYSICAL MEMORY EXPERIMENTS, by R. C. Bilger. Sept. 1959, 17p. incl. illus. diagr. (Technical memo. no. 72; rept. no. 2803-2-T) (AFOSR-TN-59-923) (AF 49(638)369) AD 229518; PB 144793
Unclassified

Equipment and operating procedures used in psychophysical memory experiments are described. This equipment gives precise control of signal parameters and permits large quantities of data to be collected. The random selection of input waveforms, the rate of signal presentation, and the observer's responses are programmed by PSYTAR (PSYchological Testing And Recording); ROMPAR (Random Orthogonal Message Presenter and Recorder) is the message-storage device used with PSYTAR. (Contractor's abstract, modified)

1211

Michigan U. [Dept. of Electrical Engineering] Ann Arbor.

GRAPHICAL PRESENTATION OF DATA IN THE FRAMEWORK OF THE THEORY OF SIGNAL DETECTABILITY, by W. P. Tanner, Jr. [1959] [2]p. incl. diagr. [AF 49(638)369]
Unclassified

Published in Jour. Acoust. Soc. Amer., v. 31: 243-244, Feb. 1959.

A discussion is presented on the graphical presentation of data relating measures of performance to signal energy in psychophysical experiments.

1212

Michigan U. [Dept. of Electrical Engineering] Ann Arbor.

EFFECT OF MEMORY FOR AMPLITUDE ON AMPLITUDE DISCRIMINATION (Abstract), by W. P. Tanner, Jr. [1959] [1]p. [AF 49(638)369]
Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1575, Nov. 1959.

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A 2 alternative forced-choice experiment (2 AFC) in which the observer is asked to state which is the larger of 2 segments of tones presented sequentially in time, is analyzed as an experiment involving only amplitude memory. Frequency, phase, starting time, and duration information is provided each trial by the stimuli. The 2 AFC experiment is conceived as 1 in which a measure of the intensity of the 1st signal serves to establish a cutoff value against which the measure of the 2nd can be compared. If the measure of the 2nd exceeds the cutoff then it is reported to be larger. If the measure of the 2nd is less than the cutoff then the 1st is reported to be larger. The variable in these experiments was the time interval, τ , between the 2 signals. Intervals from 50 to 9600 msec were studied. The efficiency in these experiments varied as the produce $(1 - e^{-C\tau})/1 + A\tau$, where C is a damping constant and A is a constant describing the variance of the cutoff.

1213

Michigan U. [Dept. of Electrical Engineering] Ann Arbor.

FREQUENCY DISCRIMINATION AS A FUNCTION OF INTERPRESENTATION INTERVAL (Abstract), by C. D. Creelman. [1959] [1]p. [AF 49(638)369]

Unclassified

Presented at meeting of the Acoust. Soc. Amer., Cleveland, Ohio, Oct. 22-24, 1959.

Published in Jour. Acoust. Soc. Amer., v. 31: 1577, Nov. 1959.

In a 2-alternative forced-choice frequency discrimination task observers were instructed to respond by indicating the presentation interval in which the higher of the 2 tones had appeared. The frequency difference between the 2 tones was fixed at 15 cps. The independent variable manipulated was the time between the 2 presentation intervals within each trial. Discrimination was measured at 9 separation times from 30 msec to 9.6 sec. The data indicate a peak in discrimination, varying among the 4 observers, with about 1-sec separation. The data are accounted for by 2 "memory" mechanisms. A short-term effect causes the 1st of 2 closely spaced signals to interfere with the 2nd. When the signals are separated by longer intervals a decaying memory of the frequency of the 1st makes comparison with the 2nd signal less precise, lowering discrimination.

1214

Michigan U. [Dept. of Mathematics] Ann Arbor.

APPLICATIONS OF THE THEORY OF MORSE TO SYMMETRIC SPACES, by R. Bott and H. Samelson. Mar. 1959 [66]p. incl. diagrs. refs. (AFOSR-TN-59-130) (AF 49(638)104) AD 210769; PB 142401

Unclassified

Also published in Amer. Jour. Math., v. 80: 964-1029, Oct. 1958.

Results announced by the authors (Proc. Nat'l. Acad. Sci., v. 4: 490-493, 1955) are proved in the present paper. Let Ω be the loop space on the connected compact Lie group K and let S be the set of geodesics on K leading from a general point to the identity. Then an explicit isomorphism γ of S_* , the free module generated by the elements of S , into $H_*(\Omega; \mathbb{Z})$, the integral singular homology group of Ω is given. To carry out the program, the authors deal with the loop space of a manifold M on which a compact Lie group K acts with at least one fixed point. Then it is proved that if the action of K on M satisfies a certain infinitesimal condition, called variational completeness, there is an isomorphism γ of S_* onto $H_*(\Omega; \mathbb{Z})$ provided that S is K -orientable (or, without assuming the K -orientability of S , an isomorphism of S_* , the vector space with integer mod 2 coefficients generated by the elements of S , onto $H_*(\Omega; \mathbb{Z}_2)$, the singular homology group of Ω with integer mod 2 coefficients). The validity of variational completeness is established in various instances all of which are associated with symmetric spaces. The rest of the paper is devoted to applications of these results to the topology of Lie groups and symmetric spaces in general.

1215

Michigan U. [Dept. of Mathematics] Ann Arbor.

A NOTE ON CARTAN'S CRITERION, by H. Samelson. June 1959, 6p. (AFOSR-TN-59-467) (AF 49(638)104) AD 215226

Unclassified

Also published in Portugal. Math., v. 18: 181-185, 1959.

A self-contained version is presented for the proof of Cartan's criterion for semi-simplicity of Lie algebras. Cartan's criterion states: the Lie algebra \mathfrak{g} is semi-simple if and only if the Killing form β is non-degenerate (i.e., $\beta(X_0, Y) = 0$ for all $Y \in \mathfrak{g}$ implies $X_0 = 0$).

1216

Michigan U. [Dept. of Mathematics] Ann Arbor.

ON THE THEOREMS OF GROSS AND INVERSEN, by A. J. Lohwater. July 1959 16p. incl. refs. (AFOSR-TN-59-550) (AF 49(638)104) AD 216660; PB 143006

Unclassified

The theory of cluster sets is considered, where the topological properties of meromorphic functions are separated from the analytic properties. The principal results are generalizations of theorems of Gross and Iversen, asserting the inclusion of the frontier of the cluster set of a function f at P in the boundary cluster set of f at P . The generalization is obtained by the introduction of a refined boundary cluster set relative to

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a set of measure 0 on the unit circle. Every value of the cluster set minus the modified boundary cluster set is assumed infinitely often near P , with the exception of a set of logarithmic capacity 0. The results include a generalization of Picard's theorem to non-isolated essential singularities. (Contractor's abstract)

1217

Michigan U. [Dept. of Mathematics] Ann Arbor.

ON IMMERSION OF MANIFOLDS, by H. Samelson.
Oct. 1959, 10p. (AFOSR-TN-59-853) (AF 49(638)104)
AD 229991; PB 145309 Unclassified

Also published in Canad. Jour. Math., v. 12: 529-534, 1960.

A simple geometrical proof, using vector fields, is given for the theorem of R. Lashof and S. Smale (Ann. Math., v. 68: 562-583, 1958) to the effect that for an imbedding of a compact manifold M into a manifold M' the normal degree equals the characteristic of M modulo 2, that of M' (or zero if M' not compact); the relevant homology class is identified. A 2nd proof using the theory of Morse is given for the special case where M' is Euclidean space. (Contractor's abstract)

1218

Michigan U. [Dept. of Mathematics] Ann Arbor.

RADIAL CLUSTER SETS AND THE DISTRIBUTION OF VALUES OF MEROMORPHIC FUNCTIONS, by W. B. Woolf. Oct. 1959, 31p. incl. refs. (AFOSR-TN-59-1041) (AF 49(638)104) AD 229490; PB 144772

Unclassified

An investigation is presented of the behavior near a singularity of a function $w = f(z)$ meromorphic in the unit disk. Emphasis is placed on the problem of deriving meaningful results for non-isolated singularities. The background of the study is traced from the classical theorems of Weierstrass and Picard to the definitions of the cluster set and various subsets thereof. The concept of capacity is reviewed and the techniques of Lohwater and a theorem of Lindelöf are adapted to prove that, if $f(z)$ is meromorphic in $|z| < 1$, then $f(z)$ assumes infinitely often in every neighborhood of a singularity P on $|z| = 1$ every value of $C(f, P) - C_R(f, P)$, with the exception of at most 2 values. Every such omitted value is an asymptotic value of $f(z)$ at P . The main theorem is proved: if $f(z)$ is meromorphic in $|z| < 1$, E is of capacity zero, P is a point of $|z| = 1$, and S is any component of $C(f, P) - C_{R-E}(f, P)$, then $f(z)$ assumes every value of S , save at most 2, in any neighborhood of P . Every such omitted value is an asymptotic value either at P or at a sequence of boundary points having P as limit point. The strength and significance

of these results lies in their application to cases where the singularities are non-isolated, and to the case that $|z| = 1$ is a singular line. (Contractor's abstract)

1219

Michigan U. [Dept. of Mathematics] Ann Arbor.

AN ACTION OF A FINITE GROUP ON AN n -CELL WITHOUT STATIONARY POINTS, by E. E. Floyd and R. W. Richardson. [1959] [4]p. (AF 49(638)104)

Unclassified

Published in Bull. Amer. Math. Soc., v. 65: 73-76, Mar. 1959.

A simplicial action of A_5 , the group of even permutations on 5 letters, on an n -cell without stationary points is given. Proof of 2 lemmas is given including (1) the coset space $SO(3)/I$ has the integral homology groups of the 3-sphere S^3 ; and (2) the action of I on $SO(3)/I$ is simplicial.

1220

Michigan U. Dept. of Mathematics, Ann Arbor.

ASYMPTOTIC SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS, by N. D. Kazarinoff. Final rept. Apr. 1959, 5p. (Rept. no. 2657-4-F) (AFOSR-TR-59-49) (AF 49(638)192) AD 215714; PB 142190

Unclassified

Three mathematical problems are investigated: (1) a Peano-like existence proof for solutions of the Goursat problem for quasi-linear equations, (2) a Runge-Kutta process for the numerical solution of this problem, and (3) the asymptotic behavior of solutions of ordinary linear differential equations having 2 simple turning points. (Contractor's abstract)

1221

Michigan U. Dept. of Mathematics, Ann Arbor.

RESTRICTED CLUSTER SETS, by P. Erdős and G. Piranian. Jan. 1960, 5p. (Rept. no. 2913-1-T) (AFOSR-TN-59-1122) (AF 49(638)633) AD 231397; PB 145543

Unclassified

Collingwood has shown that if a function f is continuous in the upper half-plane, then the real axis contains a residual set at each of whose points each Stolz cluster set of f coincides with the complete cluster set of f . It is shown that the hypothesis of continuity can be dropped from Collingwood's theorem. A function whose segmental cluster sets exhibits a large measure of independence is also described.

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Michigan U. Dept. of Physics, Ann Arbor.

GALVANO-MAGNETIC EFFECTS. PART I, by W. Tantraporn and E. Katz. Final rept. Aug. 1959, 51p. incl. illus. diagrs. tables, refs. (Rept. no. 2613-8-F) (AFOSR-TR-59-122, pt. 1) (AF 49(638)69) AD 226081; PB 144121
Unclassified

A historical preface is given. The phenomenological theory, as developed previously, is summarized, with special emphasis on applications to bismuth and gallium. The experimental method of measurement and results for bismuth are described. It is found that all resistivity brackets can be represented by the formula

$$\rho = \rho_0 T e^{-\beta/\sqrt{T}}, \text{ where } \rho_0 \text{ is a constant, different}$$

for each bracket and β depends almost exclusively on the order of the bracket. This dependence is roughly given by $\beta_n = 2n/(n+4)$. Results from the literature

for gallium are analyzed in terms of our phenomenological constants. The procedure of testing and its complications are sketched, as is the direction in which an entire new series of bracket relations is in process of being discovered by the present analysis. Comparison of limiting low-intensity reciprocity failure slope from sequence loops is made with previous measurements. A study is made of the number of quanta active in the formation of a just developable latent image as a function of grain size, density, and type of development by means of sequence loops. The method of sequence exposures is briefly described along with experimental results. The results confirm qualitatively the trend of the theoretical work but lead to quantitative difficulties, which are discussed. The conclusions are summarized. (Contractor's abstract)

1223

Michigan U. Dept. of Physics, Ann Arbor.

THE PHOTOGRAPHIC SEQUENCE EFFECT. PART II, by J. H. Enns and E. Katz. Final rept. Aug. 1959, 20p. incl. diagrs. (Rept. no. 2613-9-F) (AFOSR-TR-59-122, pt. 2) (AF 49(638)69) AD 226082; PB 144152
Unclassified

The motivation of this study is a comparison of limiting low-intensity reciprocity failure from sequence loops with direct measurements by Martin, and a study of the number of quanta active in the formation of a just developable latent image as a function of grain size, density, and type of development by means of sequence loops. The method of sequence exposures is described experimentally and theoretically. The experimental results were obtained with Eastman Kodak type 33 emulsions and with a set of emulsions consisting of nonsensitized pure AgBr emulsions of different average grain sizes. The results confirm qualitatively the trend of the theoretical work but lead to quantitative difficulties. For qualitative use the theory and the method of se-

quence-loop studies seem useful tools for the determination of the number of quanta that are involved in the formation of one just developable speck. Values in the range 3 to 20 quanta were found. This number tends to be lower for grains that require a larger total number of quanta received to become developable, indicating that the efficiency of concentrating the received energy on one speck tends to be lower for grains with smaller just developable specks. No explanation of this trend is presently available. (Contractor's abstract)

1224

Michigan U. [Engineering Research Inst.] Ann Arbor.

THE CHEMICAL AND PHYSICAL STRUCTURES OF PbS FILMS IN RELATION TO PHOTOCONDUCTIVE SENSITIVITY, by L. O. Brockway, M. S. Wasserman, and E. A. Meyers. Final rept. Dec. 1958, 56p. incl. illus. diagrs. tables, refs. (Rept. no. 2037-8-F) (AFOSR-TR-59-9) (AF 18(600)175) AD 209492
Unclassified

A study has been made of lead sulfide films with emphasis on relations between the method of preparation, physical and chemical composition, and photoconductivity. The 2 main features have been (a) an examination of particle size and orientation and of the chemical phases occurring as a function of the conditions of treatment, and (b) the relation of these compositional factors to the magnitude of the photoconductive sensitivity. The film composition was studied mainly by electron diffraction and microscopy, and the photoconductivity was measured in terms of the d-c biased film when illuminated with interrupted "black body" radiation.

1225

Michigan U. [Engineering Research Inst.] Ann Arbor.

[STRONG LUMINOUS SHOCKS PRODUCED IN SHOCK TUBES] by O. Laporte. Final rept. July 10, 1959, 3p. (Rept. no. 2189-4-T) (AFOSR-TR-59-81) (AF 18(600)-983)
Unclassified

The progress on this study of the properties of gases heated to a state of high temperature in a shock tube is summarized. At the end of 1957, a technique for the direct photography of shock waves and boundary layers in high temperature gases was developed. In early 1958, the gas properties behind the shock wave reflected from the closed end of a shock tube were studied with respect to (1) the direct and inferential measurement of hydrodynamical variables, and (2) spectrophotometric measurement of the oxidation temperature up to 10,000°K. The results were compared to the theoretical ones. Within 10% error was observed (1) in the cases with fluid density and kinetic temperature variables, and (2) in the temperature range between 5000 - 5900°K. It is suggested that future studies should be concentrated in the areas of (a) microwave emission from

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shock-ionized gases, (b) discharge-induced blast and shock waves, and (c) magnetohydrodynamics in conducting liquids and gases.

1226

Michigan U. [Engineering Research Inst.] Ann Arbor.

AN EXPERIMENTAL INVESTIGATION OF THE POSSIBILITY OF ACHIEVING A STANDING DETONATION WAVE, by J. A. Nicholls, E. K. Dabora, and R. S. B. Ong. Final rept. July 1, 1954-Jan. 31, 1959. July 1959, 23p. incl. illus. diagrs. refs. (Rept. no. 2284-23-F) (AFOSR-TR-59-132) (AF 18(600)1199) AD 226658; PB 143908
Unclassified

The properties of gaseous detonation waves and the conditions that must be met to generate stable waves are described and discussed, as is the experimental facility which evolved as a result of these considerations. Preliminary experiments leading to the 1st known case of a stabilized detonation wave (probably very close to the Chapman-Jouguet case) are also described. In these experiments an ignition time delay has been detected between the shock wave and onset of combustion. It appears that this experimental technique has great potential in the study of chemical kinetics as well as in the study of stabilized detonation waves. Preliminary analytical work on the stability of a plane detonation wave is discussed.

1227

Michigan U. [Engineering Research Inst.] Ann Arbor.

STABILIZED GASEOUS DETONATION WAVES, by J. A. Nicholls. [1959] [2]p. incl. diagr. (AF 18(600)1199)
Unclassified

Published in ARS Jour., v. 29: 607-608, Aug. 1959.

An elaboration of the experimental procedure and results obtained in this laboratory on stabilized detonation wave research is presented as a reply to Gross's comments (FEA.01:005, Vol. II and 526, Vol. III) on this work. A review of the research is presented starting with the 1st AFOSR supported work done in 1954. Attention is directed to the work concerned with the ignition time delay for the given pressure, temperature, and mixture ratio existing downstream of the shock. It is shown that since the ignition time delay is an essential function of reciprocal temperature, it is not surprising that in those cases in which partial premature combustion in the nozzle is experienced, the delay decreases to shorter times than can be resolved experimentally. It is also pointed out that the light emission realized for appreciable distances downstream can be due to the sodium chloride injected into the air stream.

1228

Michigan U. [Engineering Research Inst.] Ann Arbor.

COMBUSTION EXPERIMENT WITH A 50,000-CURIE GOLD SOURCE, by S. W. Churchill, A. Weir, Jr. and others. Nov. 1959, 15p. incl. illus. diagrs. (Rept. no. 2226-9-T) (AFOSR-TR-59-185) (AF 18(600)1218) AD 234757
Unclassified

The data obtained in a previous experiment (MIC.09:001, Vol. I) in which the flame zone and preflame zone of premixed propane and air were both irradiated with a 12,000-curie gold source have been reworked and reinterpreted for journal publication (Ind. Eng. Chem., v. 49: 1419-22, 1423-28, Sept. 1957; see also item nos. MIC.09:002, 003, Vol. II). The previously reported effects of irradiation on the flame speed and emission spectra of the flames were reconfirmed, but the uncertainty in the recomputed OH-rotational temperature was found to be greater than the observed variation with source strength and hence was not determinable from these data. A new experiment was designed to irradiate the flame and preflame zones separately under essentially the same conditions. An accidental explosion in the test chamber shortly after installation of the radioactive gold damaged the burner and the optical transmission system used for remote observation of the flame, preventing collection of the intended data. The details of the experimental design and the history of the experiment are nevertheless reported as a guide to future research of a similar nature.

1229

Michigan U. [Engineering Research Inst.] Ann Arbor.

AN INVESTIGATION OF REACTIONS INVOLVED IN THE PREPARATION OF FERRITES, by C. F. Jefferson. Jan. 1959 [115]p. incl. illus. diagrs. tables, refs. (Technical rept. no. 7) (AFOSR-TN-59-218) (AF 18(603)6) AD 211780; PB 140623
Unclassified

The purpose of this study was to investigate some solid-state reactions involved in the preparation of ferrites. By means of microscopic examination of polished sections, chemical analysis, x-ray analysis, density measurements, and magnetic measurements such as the Curie temperature and saturation moment/gram, the phase relationships, kinetics of the spinel reaction in several different atmospheres, and the densification process have been studied in the systems (Ni, Zn)O-Fe₂O₃ and Li₂O-Fe₂O₃. Some magnetic properties of ferrites contained in the system Ni_xZn_{1-x}Fe₂O₄-Fe₂O₃ are correlated with the method of preparation. By differential thermal analysis, chemical analysis, and saturation moment measurements, the progression of the oxidation of the systems Ni_{.474}Zn_{.526}Fe₂O₄-Fe₃O₄ and LiFe₅O₈-Fe₃O₄ has been followed. The temperature at

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which $\gamma\text{Fe}_2\text{O}_3$, which forms during the oxidation of the above systems, transforms to $\alpha\text{Fe}_2\text{O}_3$, has been determined as a function of the composition.

1230

Michigan U. [Engineering Research Inst.] Ann Arbor.

MAGNETIC PROPERTIES OF POLYCRYSTALLINE MATERIALS, by D. M. Grimes, R. D. Harrington, and A. L. Rasmussen. Feb. 1959 [37]p. incl. diagrs. tables. (Technical rept. no. 8) (AFOSR-TN-59-272) (AF 18-(603)8) AD 212706; PB 140777 Unclassified

Also published in Jour. Phys. Chem. Solids, v. 12: 28-40, Dec. 1959.

The variation of the magnetic Q with internal magnetization is discussed using the domain rotation and the domain-wall motion model of magnetization change. The variation of the reversible susceptibilities with magnetic moment is reported on 4 samples, and the results are compared with results from the frequency spectra in the initial and remanent states. The distribution of magnetic moments in the system as a function of angle between individual and averaged moments is discussed in terms of an infinite series expansion in Legendre polynomials. The coefficients of the first 4 terms can be measured. Experimental data are given for the first 3. (Contractor's abstract)

1231

Michigan U. [Engineering Research Inst.] Ann Arbor.

SOME DETAILS OF THE TRANSITION TO TURBULENT FLOW IN POISEUILLE FLOW IN A TUBE, by A. M. Kuethe and K. R. Raman. June 1959, 31p. incl. illus. diagrs. refs. (AFOSR-TR-59-84) (AF 18(603)34) AD 232746 Unclassified

Measurements of velocity fluctuations, Reynolds stresses and shearing stresses at the wall in the transition region of a tube are presented. The measurements are made in a tube at a Reynolds number of 6000 behind 3 disturbance generators placed in the fully developed laminar flow 620 diam from the entrance. The results show the way in which some of the statistical details of the transition depend on the nature of the disturbance generated. The Reynolds stresses and the shearing stress at the wall can reach very high values during the early stages of transition. Implications are pointed out regarding possible causes for the high temperature recovery factor during transition in high speed flow over surfaces. (Contractor's abstract)

1232

Michigan U. [Engineering Research Inst.] Ann Arbor.

STAGNATION POINT FLUCTUATIONS ON A BODY OF REVOLUTION, by A. M. Kuethe, W. W. Willmarth, and G. H. Crocker. [1959] [3]p. incl. diagrs. table, refs. [AF 18(603)34] Unclassified

Published in Phys. Fluids, v. 2: 714-716, Nov.-Dec. 1959.

Results of investigations carried out on bodies of revolution in a low-turbulence tunnel and in a supersonic tunnel are presented. The measurements of relative rms velocity fluctuations are shown. It is pointed out that the bodies had hemispherical noses with diameters 2 in., 11.7 in., and 20 in., and fineness ratios 17, 6.3 and 5.2, respectively. Results indicate that the low frequency components in the free stream fluctuations are amplified strongly in the region near the stagnation point. A measurement of the correlation coefficient was made on the 2-in.-diam model at a Mach number of 2.44 in the supersonic tunnel. The observations indicate that at supersonic as well as at subsonic speeds a random wandering of the stagnation point occurs.

1233

Michigan U. Engineering Research Inst., Ann Arbor.

ON AXISYMMETRIC VIBRATIONS OF THIN SHALLOW VISCO-ELASTIC SPHERICAL SHELLS, by P. M. Naghdi and W. C. Orthwein. Jan. 1959, 27p. incl. diagrs. refs. (Technical note no. 5; rept. no. 2500-6-T) (AFOSR-TN-59-109) (AF 18(603)47) AD 210389; PB 140239 Unclassified

Transverse vibrations of shallow viscoelastic spherical shells subjected to axisymmetric loads which are harmonic in time are discussed. In particular, the steady state solution is obtained for an unlimited viscoelastic shallow shell subjected to an oscillating load uniformly distributed over a small circular region about the apex. Numerical results for axial displacement and stresses are obtained for 2 special viscoelastic media (Maxwell and Kelvin) as well as for the elastic shell, and comparison is made with known results. (Contractor's abstract)

1234

Michigan U. [Engineering Research Inst.] Ann Arbor

THERMO-ELASTICITY AND VISCO-ELASTICITY IN STRUCTURES, by P. M. Naghdi. Final rept. Feb. 1959, 5p. (Rept. no. 2500-7-F) (AFOSR-TR-59-33) (AF 18-(603)47) AD 212470 Unclassified

The results of the work completed under this contract are described in the following publications: (1) On Elastic Plates of Variable Thickness, by F. Essenburg and P. M. Naghdi (item no. MIC.18:001, Vol. II); (2) On

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Axially Symmetrical Plates of Variable Thickness, by F. Essenburg (item no. MIC.18:002); (3) Response Of Shallow Viscoelastic Spherical Shells to Time-Dependent Axisymmetric Loads, by P. M. Naghdi and W. C. Orthwein (item no. MIC.18:003); (4) On Thermo-Elastic Stress Relations For Thin Isotropic Shells, by P. M. Naghdi (item no. MIC.18:004); and (5) On Axisymmetric Vibrations of Thin Shallow Viscoelastic Spherical Shells, by P. M. Naghdi and W. C. Orthwein (item no. 1233, Vol. III).

1235

Michigan U. [Engineering Research Inst.] Ann Arbor.

APPLICATION OF LOGIC TO THE DESIGN OF COMPUTING MACHINES, by A. W. Burks, H. Wang, and J. Holland. Final rept. Aug. 1959 [9]p. (Rept. no. 2512-4-F) (AFOSR-TR-59-106) (AF 18(603)72) AD 226604; PB 146390 Unclassified

The results previously obtained on fixed automata (MIC.13:001, Vol. I) are summarized. Results obtained on growing automata are reviewed. A universal computer is described which is capable of simultaneously executing an arbitrary number of sub-programs. The number of such sub-programs vary as a function of time under program control or as directed by input to the computer. Three features of the computer are: (1) the structure of the computer is a 2-dimensional modular (or iterative) network; (2) each sub-program is spatially organized, thus facilitating the simulation of highly parallel systems having many points or parts; and (3) the computer's structure and behavior can, with simple generalizations, be formulated so as to make it a useful abstract tool for investigating problems in automata theory.

1236

Michigan U. [Research Center for Group Dynamics] Ann Arbor.

REDUNDANCY IN TASK ASSIGNMENTS AND GROUP PERFORMANCE, by R. B. Zajonc and W. H. Smoke. [1959] [9]p. incl. diagrs. refs. (AFOSR-TN-59-657) (AF 49(638)367) AD 238805 Unclassified

Published in Psychometrika, v. 24: 361-369, Dec. 1959.

The problem of combining abilities of group members to maximize the performance of the group as a whole is examined in terms of redundancy in task assignments. In particular, ways of distributing a given number of items of information among a given number of individuals to obtain the maximum probability of each item being recalled by at least one individual are studied. It is shown that there exists an optimal distribution scheme which is independent of the amount of material originally given, the size of the group, and individual differences in ability. (Contractor's abstract)

1237

Michigan U. Willow Run Labs., Ann Arbor.

SUM RULES AND RELATIVE INTENSITIES FOR PARAMAGNETIC IONS OF SPIN 3/2, by C. Kikuchi. [1959] 16p. incl. tables. (AFOSR-TN-59-219) ([Sponsored jointly by] Air Force Office of Scientific Research under AF 49(638)68 and [Signal Corps under A 36-039-sc-78801]) AD 211901; PB 142751 Unclassified

Certain sum rules for cross-checking numerical calculations needed in the design of masers are derived, and the results obtained by using these sum rules are compared with the values calculated by machines. In addition, it is shown that the intensities for complementary transitions are equal when the r-f field is parallel to the d-c magnetic field. (Contractor's abstract)

1238

Michigan U. Willow Run Labs., Ann Arbor.

RESONANCE ABSORPTION OF PARAMAGNETIC IONS WITH SPIN 5/2: $\text{CaCO}_3\text{:Mn}$, by C. Kikuchi. Feb. 18, 1959 [29]p. incl. diagrs. tables, refs. (AFOSR-TN-59-220) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)68 and Signal Corps under [DA 36-039-sc-78801]) AD 211802; PB 143181 Unclassified

The theory of the paramagnetic resonance absorption of ions with $S = 5/2$ in crystalline fields of trigonal symmetry is presented using manganous ions in calcite as an example. It is shown that the experimental results observed by Hurd, Sachs, and Hershberger (Phys. Rev., v. 93: 373, 1954) can be accounted for by assuming that the manganous ions occupy the 2 nonequivalent Ca^{2+} sites at random. Much of the theory presented here is also applicable to $\text{Al}_2\text{O}_3\text{:Fe}$, which is a potential material for a zero-field maser. (Contractor's abstract)

1239

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE OF V^{2+} , V^{3+} , V^{4+} IN $\alpha\text{-Al}_2\text{O}_3$, by J. Lambe and C. Kikuchi. Nov. 1959, 30p. incl. diagrs. table, refs. (Rept. no. 2616-12-R) (AFOSR-TN-59-922) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)68 and Signal Corps under DA 36-039-sc-78801) AD 229527; PB 144569 Unclassified

Also published in Phys. Rev., v. 118: 71-77, Apr. 1, 1960.

Divalent vanadium has properties similar to those of trivalent chromium in sapphire, which has wide application in masers. The electron-spin resonance absorption

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properties of vanadium sapphire are reported here. It is shown that vanadium normally is predominantly trivalent, with a small amount being in the tetravalent state. By x- or gamma-irradiation, vanadium is converted to the divalent state. The hyperfine-structure component separation for V^{2+} , V^{3+} , and V^{4+} are about 88, 110, and 140 gauss, respectively. Because of its readily recognizable spin-resonance signature due to its nuclear spin, and because of the ease of producing different oxidation states, it is suggested that vanadium may be a suitable probe with which to study ionization effects in certain solids. (Contractor's abstract)

band frequency of di- and tri-valent vanadium in corundum single crystal, grown by Linde from 0.1% V_2O_5 powder mixture have been detected. In the magnetic resonance spectrometer, a lavite cavity was used. After x- and Co-60 gamma-irradiation, a spectrum detectable at room temperature can be developed, consistent with the assignment $S = 5/2$ and $I = 7/2$, suggesting V^{++} . The tentative values of the parameters in the spin-Hamiltonian are $A \sim B = 88$ gauss; $D \sim 9.4$ kmc/sec, and $g(V^{++}) \sim g(Cr^{+++})$. The V^{+++} signal is detected at 4.2°K. The hfs is strongly anisotropic varying from 110 gauss at 0° to more than 350 gauss near 90°.

1240

Michigan U. Willow Run Labs., Ann Arbor.

CERTAIN SUM RULES APPLICABLE TO PARAMAGNETIC IONS OF SPIN 3/2 (Abstract), by C. Kikuchi. [1959] [1]p. [AF 49(638)68] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 261, Apr. 30, 1959.

In the design of masers, it is often necessary to carry out extensive numerical calculations because the crystalline field and Zeeman terms are comparable. The purpose of the present paper is to indicate that certain sum rules can be used to cross-check the numerical work. For example, if the crystalline field has axial symmetry, the sums of the relative intensities of the six possible transitions are given by $\sum I_{M'M}^{(x)} = 12 \cos^2 \theta + 5x^2$, $\sum I_{M'M}^{(y)} = 12 + 5x^2$, $\sum I_{M'M}^{(z)} = 12 \sin^2 \theta$, when the rf field is along the x-, y-, and z-axis, respectively. Here the z-axis is taken along the c-axis, the dc magnetic field H in the xz-plane at angle θ from z, and $x = g\beta H/|D|$. It is interesting to note that the intensities of complementary transitions are equal for any crystal orientation, if the rf field is along the dc magnetic field.

1241

Michigan U. Willow Run Labs., Ann Arbor.

ELECTRON SPIN RESONANCE OF V^{++} AND V^{+++} IN CORUNDUM (Abstract), by J. Lambe, R. Ager, and C. Kikuchi. [1959] [1]p. [AF 49(638)68] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 261, Apr. 30, 1959.

The paramagnetic resonance absorption signals at X-

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Michigan U. Willow Run Labs., Ann Arbor.

X-RAY COLORATION OF RUBY (Abstract), by J. H. Mathews and J. Lambe. [1959] [1]p. [AF 49(638)68] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 284, Apr. 30, 1959.

Ruby exhibits an x-ray coloration well in excess of that of white sapphire and anomalously dependent on chromium concentration. The induced optical density first increases and then decreases with chromium concentration. Absorption measurements on annealed, synthetic sapphires (Linde) with 0 to 4% Cr_2O_3 "nominal powder concentration" show a broad radiation-induced band, peaking at about 4700A, and a second band near the absorption edge. Induced absorption coefficients reach 5 and 25 cm^{-1} at 4700 and 2300A, respectively, at saturation. Similar effects are observed with Co⁶⁰ gamma irradiation. The sensitizing effect of the chromium ion may be due to its providing, under irradiation, electrons for color centers. The anomalous down-turn of irradiation coloration at the higher chromium concentrations would appear to exclude as dominant sensitization mechanism a simple furnishing, by the chromium ions, of sites for potential color centers.

1243

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE OF GAMMA IRRADIATED ALKALI HYDRIDES (Abstract), by I. Scarisbrick. [1959] [1]p. [AF 49(638)68] Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 326, June 18, 1959.

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The defect structure of the lithium lattice, which possesses both ionic and covalent character, has been investigated by ESR and optical methods. The ESR of crystals colored by Co^{60} gamma radiation has been examined at room temperature, 77°K and 4°K. At room temperature, two species of spin center are observable, both with $g = 2.0021 \pm 0.0003$ relative to an assumed value of 2.0036 for polycrystalline DPPH. One is produced only by high-gamma dosages and shows a 15% angular variation in width, which is less than three-quarters that of polycrystalline DPPH at room temperature. With low dosages, a line almost ten times broader is observed. At low temperatures, highly irradiated samples show both the sharp and broad lines, together with a third of higher g value. These and other results on irradiated crystalline LiH and also polycrystalline alkali hydrides and deuterides will be presented.

1244

Michigan U. Willow Run Labs., Ann Arbor.

MICROWAVE CAVITIES FOR MAGNETIC RESONANCE SPECTROMETERS, by J. Lambe and R. Ager. [1959] [2]p. [AF 49(638)68] Unclassified

Also published in Rev. Scient. Instr., v. 30: 599, July 1959.

A study was carried out with hydrous aluminum silicate (available commercially as Grade A Lava from American Lava Corp., Chattanooga, Tenn.), which may prove to be a more flexible material in designing a cavity. In this case, a cavity operating in the TE012 mode at 9400 mc was made with the dimensions of X-band wave guide. It was split along the broad face since this did not affect the cavity operation. The material pieces were then fired and coated. A coating of Ag paint, such as Hanovia No. 32A, fired at 850°C, was satisfactory. A thin coating of Au evaporated over this, protected the Ag coating and improved the performance. The 2 pieces were then held together with teflon screws, 1 of the pieces having threaded holes. Alternatively, the cavity can be permanently cemented together with Eastman 910 cement. Such cavities have an unloaded Q of approximately 5000 at room temperature and 20,000 at He temperature. A short length of wave guide was also made with this material and coated with Ag paint. The cavity was attached to this with teflon screws so that no heavy metal parts were in the modulation field.

1245

Michigan U. Willow Run Labs., Ann Arbor.

PHOTOSENSITIVE SPIN RESONANCE IN CdS, by J. Lambe, J. Baker, and C. Kikuchi. [1959] [4]p. incl. diagr. [AF 49(638)68] Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 270-271, Sept. 15, 1959.

The direct observation of trapping centers in CdS crystals containing traces of Fe impurities was carried out by paramagnetic resonance techniques. Spin resonance was observed at 4.2°K but not at 77 or 300°K. The spin of the center is 5/2, as for a combination of cubic and axial electric fields, $g = 2.01$. Satellites are doubled; the $-\frac{1}{2} \leftrightarrow \frac{1}{2}$ central line is also split and is due to 2nd-order effect. Hence, the photosensitive center is assigned tentatively to Fe^{3+} . These effects are interpreted as follows: Fe^{2+} in CdS traps a hole to become Fe^{3+} which is readily observable. The electrons must be trapped elsewhere and may be restored to the Fe^{3+} by 2 micron light. This latter point is yet to be determined. It is concluded that this technique should be extremely useful in testing various models of phosphors and photoconductors.

1246

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE AND OPTICAL EFFECTS OF RADIO-ACTIVELY PREPARED Rb^{85} IN SOLID Kr, by J. Lambe and J. Baker. Oct. 12, 1959 [7]p. incl. diagr. [AF 49-(638)68] Unclassified

Experiment was carried out by mixing 100 mc of Kr^{85} with 500 cc Kr and holding the mixture at 4.2°K in a quartz tube. Observations were then made using X-band (9100 mc) paramagnetic resonance spectrometer to study the accumulating Rb^{85} . The formation rate of Rb^{85} was 3.7×10^9 ions/sec. A spectra was obtained after 20 hr and clearly identified with Rb^{85} . It consisted of 6 lines ($I = 5/2$ for Rb^{85}) with a large hyperfine splitting, 1 of which was obscured by a large unknown signal at 3250 gauss. Also H_2 lines were observed. Subsequently, measurements were made at 77°K. The results showed that H_2 and quartz lines were readily detected, but the Rb spectra could barely be observed. Preliminary optical studies were made by shining light on the sample while the ESR was observed. It was found that the signal from Rb^{85} could be bleached out in about 10 min with light in the 4200A. Longer wavelengths did not give this effect. The obtained Rb^{85} is embedded in a matrix with paramagnetic centers. No anisotropy was produced with saturation microwave power on the Rb^{85} .

1247

Michigan U. Willow Run Labs., Ann Arbor.

SPIN RESONANCE OF ATOMIC TRITIUM AT 4.2°K (Abstract), by J. Lambe, J. Baker, and I. Scarisbrick. [1959] [1]p. [AF 49(638)68] Unclassified

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Presented at meeting of the Amer. Phys. Soc.,
Cleveland, Ohio, Nov. 27-28, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
418, Nov. 27, 1959.

A method of radioactive decay has been used to prepare atomic tritium at liquid helium temperatures. In this method molecular tritium is frozen in a container as a small crystal of tritium or in a noble gas matrix. When one of the atoms of a tritium molecule decays, it becomes He^3 , leaving behind the other atom of tritium. This atom can then be studied by conventional techniques of paramagnetic resonance. In our experiment, 1 cc at STP of tritium gas was used. This is 2.6 curies. The tritium emits a weak beta particle which is easily shielded. This amount was frozen out in a quartz tube at 4.2°K. This amount of tritium will produce about 10^{11} atoms per sec. It required about 5 min to begin measurements, at which time one should have 3×10^{13} spins. Two main hyperfine lines are observed with a separation of 542 gauss as one would expect for tritium. This signal increases steadily. A second small hyperfine group is observed with a spacing of 510 gauss. This group does not grow. It is believed to be due to a species, perhaps atomic hydrogen, present in the gas before the freezing. High microwave power satellites were not observed. To test whether self-radiation damage was a major effect, the tritium was frozen out in a neon matrix so that the neon would take up the effect of the beta particle. The tritium signal was again present and grew with time. It is therefore believed that the preparation process is one of radioactive decay and not a radiation damage process.

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Midwest Research Inst., Kansas City, Mo.

EXPANSION OF THE CONFLUENT HYPERGEOMETRIC FUNCTION IN SERIES OF BESSEL FUNCTIONS, by Y. L. Luke. Apr. 15, 1959, 31p. incl. refs. (AFOSR-TN-59-134) (AF 49(638)66) AD 210862; PB 142373 Unclassified

Also published in Math. Tables and Aids Comput., v. 13: 261-271, 1959.

An expansion is derived in series of Bessel functions of integral order whose argument is independent of the parameters a and c . The expansion is advantageous for many purposes of computation since the parameters and variable of the confluent hypergeometric function $\Phi(a, c, z)$ appear in separated form. Also, for desk calculation, extensive tables of $I_n(z)$ are available, while for automatic computation, Bessel functions are easy to generate. Special cases of the confluent function such as the incomplete gamma function are also studied. For the class of transcendents known as the error functions, including the Fresnel integrals, it

is shown that the expansion coincides with that of Buchholz. By specializing a parameter and passing to a limit, expansions are derived for the exponential integral and related functions. Other expansions for error and exponential integrals are derived on altogether different bases. Some numerical examples are presented to manifest the efficiency of the formula. (Contractor's abstract)

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Midwest Research Inst., Kansas City, Mo.

EXPANSION OF THE GAUSSIAN HYPERGEOMETRIC FUNCTION IN SERIES OF FUNCTIONS OF THE SAME KIND, by R. L. Coleman and Y. L. Luke. Aug. 15, 1959, 13p. (AFOSR-TN-59-734) (AF 49(638)66) AD 225713; PB 143772 Unclassified

An expansion is derived of the hypergeometric function ${}_2F_1(a, b; c; z)$ in series of hypergeometric functions with changed argument. For special values of the parameters the expansion simplifies considerably and is advantageous due to the change in argument which yields more rapidly converging series. Known Chebyshev type expansions are derived for the logarithm and arc tangent functions. The Gauss transformation for the complete elliptic integral of the 1st kind is the special case $a = b = \frac{1}{2}$, $c = 1$. A rapidly converging expansion of the complete elliptic integral of the 1st kind is derived for modulus near 1. (Contractor's abstract)

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Midwest Research Inst., Kansas City, Mo.

A RADIOACTIVE TRACE INVESTIGATION OF THE MECHANISM OF MoS_2 AND WS_2 LUBRICATION, by M. T. Lavik and S. L. Levy. June 1958, 6p. incl. diagr. table. (AFOSR-TR-59-10) (AF 49(638)157) AD 209493 Unclassified

Tests were conducted to investigate a theory of lubrication by MoS_2 (V. R. Johnson and G. W. Vaughn, Jour.

Appl. Phys., v. 27: 1173-1179, Oct. 1956). Lubrication was considered to be affected by an adsorbed S layer supplied by the mechanical breakdown of MoS_2 . The

tests were made in the friction chamber and vacuum system described previously (Rev. Sci. Instr., v. 27: 611-613, Aug. 1956) which had been modified to include facilities for collection and detection of the evaporated S. MoS_2 pellets were activated by neutron irradiation and placed in the apparatus for measurements. Increases in the coefficients of friction which had been observed after stopping a friction run were attributed to evaporation of the S layer from the test track. Measurements

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of the soft β -emission of the collection chamber indicated that some evaporated S was present, but the number of counts measured above background was insufficient for the development of firm conclusions on the project.

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Midwest Research Inst., Kansas City, Mo.

FLUTTER OF CURVED PANELS, by J. E. Yates and E. F. E. Zeijdel Sept. 1959, 38p. incl. diagrs. (AFOSR-TR-53-163) (AF 49(638)429) AD 227985; PB 144486
Unclassified

To investigate flutter of curved panels, the general equations of motion of shallow cylindrical shells are developed. The initial curvature is then taken as circular in the chordwise direction. The special case of infinite aspect ratio is considered and appropriate equations are developed for finite aspect ratio panels. Linearized 3-dimensional aerodynamic forces are incorporated in the flutter equations of motion. For simplicity, numerical results are obtained by utilizing quasi-steady aerodynamic forces. Results are obtained for unit and infinite aspect ratio curved panels with simply supported edges for 2 Mach numbers ($M = 1.5$ and 2). The flutter boundaries clearly indicate the strong dependence of panel flutter on curvature. Increasing curvature has a destabilizing effect on the panel up to a certain critical value of curvature. At the critical value, the frequencies of the 1st and 2nd chordwise modes coalesce and very large thickness is required for stability. Beyond this critical value, increasing curvature has a stabilizing effect, but it is proved that 2 mode results are unconservative in this region due to a frequency coalescence between the 1st and 3rd chordwise modes. In this region, it is concluded that at least 3 or more modes must be used to obtain reliable flutter boundaries for curved panels. (Contractor's abstract)

1252

Milan U. (Italy).

STUDY OF IRIIDIUM COMPOUNDS, by L. Malatesta. Oct. 31, 1958, 35p. incl. tables. (Technical scientific note no. 1) (AFOSR-TN-59-123) (AF 61(052)83) AD 210428; PB 138718
Unclassified

The previously unknown potassium bromocarbonyl-iridates of the type $K_2[Ir_2(CO)_4Br_5]$ have been prepared from the reaction of carbon monoxide with K_2IrBr_6 at high pressure. The mode of formation and the possible structure of these compounds, and of their analogous ones, $K_2[Ir(CO)_4Cl_5]$, are discussed. Some other halogenocarbonyl iridates deriving from the anions $[Ir^I(CO)_2Br_2]^-$, $[Ir_2^I(CO)_4Br_3]^-$, $[Ir_2(CO)_4Br_4]^-$, $[Ir^{III}(CO)Br_4]^-$, $[Ir^{II}(CO)Br_3]^-$ and $[Ir_2(CO)_2Cl_4]^-$ have

been obtained by condensation, splitting and oxidation reactions from $K_2[Ir_2(CO)_4Br_5]$ and $K_2[Ir_2(CO)_4Cl_5]$ and isolated as tetraphenylarsonium salts. The condensed potassium salt $K[Ir(CO)_4Cl_4]$ and the free acid

$H[Ir_2(CO)_4Cl_4] \cdot 4H_2O$ have been isolated. From the reaction of these chloro and bromocarbonyl derivatives with amines, the very stable non electrolytic iridium(I) derivatives $Ir(CO)_2(Amine)Cl$ and $Ir(CO)_2(Amine)Br$ have been prepared and are described. (Contractor's abstract)

1253

Milan U. (Italy).

[STUDIES ON RHENIUM AND IRIIDIUM COMPOUNDS] by L. Malatesta. Annual summary rept. no. 1, Apr. 1, 1958-Mar. 31, 1959 [?]p. (AFOSR-TN-59-642) (AF 61(052)83)
Unclassified

A brief report is made of the progress to date on the preparation and study of rhenium carbonyl compounds and derivatives of monovalent iridium which may or may not contain carbon monoxide.

1254

Milan U. (Italy).

RHENIUM COORDINATION COMPOUNDS, by L. Malatesta. Oct. 31, 1959, 15p. (Technical scientific note no. 2) (AFOSR-TN-59-1081) (AF 61(052)83) AD 232075; PB 145675
Unclassified

New coordination compounds of rhenium(I), rhenium(II), and rhenium(III) with halogens, triphenylphosphine (PR_3), and CO are described. From Re_2O_7 , PR_3 , and HCl the compound $ReCl_3(PR_3)_2$ is obtained, while HBr and HI give $ReBr_2(PR_3)_2$ and $ReI_2(PR_3)_2$. These latter are easily oxidized, by the corresponding halogen, to $ReBr_3(PR_3)_2$ and $ReI_3(PR_3)_2$. $ReCl_3$ and PR_3 gives instead $ReCl_3(PR_3)$. These compounds with CO at high pressure (200 atm) give derivatives of rhenium(II) containing both PR_3 and CO, i.e., $ReX(PR_3)_2(CO)_2$, $ReX(PR_3)_2(CO)_3$, where X is Cl or Br, and $ReI(PR_3)_2CO$. (Contractor's abstract)

1255

Milan U. Inst. of General Pathology (Italy).

PROTEIN SYNTHESIS IN VACUOLATED RAT LIVER CELLS, by A. Bernelli-Zazzera and G. Guidotti. [1958] [5]p. incl. illus. tables, refs. [AF 61(514)1026]
Unclassified

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Published in *Exper. Cell Research*, v. 14: 614-618, June 1958.

The incorporation of C-labeled glycine, leucine and phenylalanine into liver proteins has been studied on slices from normal and vacuolated rat liver. Vacuolated liver cells incorporate these amino acids at a rate significantly lowered as compared with normal controls. The release of protein-N and amino-N from the slices into the incubation medium is the same in normal and vacuolated cells. The synthesis of p-amino-hippuric acid from p-aminobenzoic acid and glycine, which has been chosen as an example of peptide bond synthesis, is impaired in vacuolated liver cells. The possible relationship of these observations to protein synthesis and general metabolism of vacuolated liver cells are discussed. (Contractor's abstract)

1256

Milan U. Inst. of General Pathology (Italy)

[CONTENT IN DIPHOSPHOPYRIDINE NUCLEOTIDE OF THE LIVER IN TURBID SWELLING AND OF THE VACUOLIZED LIVER] Contenuto in difosfopiridinucleotide del fegato in rigonfiamento torbido e del fegato vacuolizzato, by C. Severi, A. Fonnesu, and C. Agostini. [1957] [4]p. incl. table. (AFOSR-TN-59-833) (AF 61-514)1026) Unclassified

Also published in *Atti Soc. Ital. Patol.*, v. 5: 513-516, June 1957.

Variations of the diphosphopyridine nucleotide (DPN) and the relationship between the oxidized and reduced forms of this coenzyme (DPN⁺/DPNH) in turbidly swollen liver and in vacuolized liver are studied. The tests were carried out on albino rats fed a standard diet. The turbid swelling of the liver was caused with 1 DML of endotoxin from endoperitoneal *S. typhimurium* and the vacuola degeneration of the liver was obtained keeping the animals for 2 hr in an atmosphere of 97% N₂-3% O₂.

The group of animals was separated into 2 groups, one for 45 min of fresh air and the other group was killed immediately after the treatment. The results are summarized in a table.

1257

Milan U. Inst. of General Pathology (Italy).

DIPHOSPHOPYRIDINENUCLEOTIDE CONTENT OF LIVERS AFFECTED BY CLOUDY SWELLING AND BY CELL VACUOLATION, by C. Severi-Fonnesu, A. Fonnesu, and C. Agostini. [1958] [8]p. incl. tables, refs. (AFOSR-TN-59-834) (AF 61(514)1026) AD 226152 Unclassified

Presented at Fifth Cong. of the Ital. Patol. Soc. Milan-Como (Italy), June 9-11, 1957.

Also published in *Ital. Jour. Biochem.*, v. 7: 226-233, July-Aug. 1958.

Oxidized (DPN⁺) and reduced (DPNH), diphosphopyridine-nucleotides were determined in normal rat liver, in the liver with cloudy swelling produced by *salmonella typhimurium* toxin, and in liver with cell vacuolation induced by hypoxia. DPN content as well as the ration DPN⁺/DPNH are unchanged in either liver showing cloudy swelling or in liver affected by cell vacuolation as compared with normal controls. The results are briefly discussed in the light of the most significant biochemical changes which have been previously found in cloudy swelling and in vacuolated liver. (Contractor's abstract)

1258

Milan U. Inst. of General Pathology (Italy).

COENZYME A CONTENT IN LIVERS AFFECTED BY VARIOUS DEGENERATIVE CHANGES, by C. Severi-Fonnesu, A. Fonnesu, and C. Agostini. [1958] [10]p. incl. tables, refs. (AFOSR-TN-59-835) (AF 61(514)1026) AD 226153 Unclassified

Also published in *Ital. Jour. Biochem.*, v. 7: 215-225, July-Aug. 1958.

See item no. MIL.01:001, Vol. II for abstract.

1259

Milan U. Inst. of General Pathology (Italy).

[THE IN VITRO INCORPORATION OF 1-C¹⁴-GLYCINE INTO THE PROTEINS OF NORMAL AND VACUOLATED RAT LIVERS] Incorporazione in "vitro" della glicina-1-¹⁴C nelle proteine di fegato normale e vacuolizzato del ratto, by G. Guidotti and E. Bazzano. [1958] [3]p. incl. diagrs. tables, refs. (AFOSR-TN-59-836) (AF 61-514)1026) Unclassified

Presented at Internat'l. meeting of Nuclear Med., Turin (Italy), June 5-7, 1957.

Also published in *Minerva Nucleare*, v. 2: 22-24, Feb. 1958.

Liver vacuolation for the study involving glycine incorporation by keeping rats in an atmosphere of 97% nitrogen and 3% oxygen for 2 hr. Warburg vessels were used to carry out the incorporation. The results show that a first order relation between time and incorporation rate exists during the whole experiment in both normal and vacuolated livers. The incorporation rate is significantly decreased at each time in vacuolated livers. These results are discussed in connection with the energetic requirements of the liver cell.

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Milan U. Inst. of General Pathology (Italy).

THE METABOLISM OF ISOLATED CEREBRAL CORTEX FROM HYPOXIC RATS, by A. Bernelli-Zazzera, M. Bassi, and E. Cassi. [1959] [6]p. incl. tables, refs. (AF 61(514)1026) Unclassified

Published in *Exper. Cell Research*, v. 18: 554-559, Nov. 1959.

The oxidation of glucose, glutamate, pyruvate and lactate, the respiratory quotient and aerobic and anaerobic glycolysis have been studied on brain cortex slices from hypoxic rats. No difference has been found as compared with normal rats. It seems therefore that the brain is less affected than the liver by the same hypoxia conditions. The incorporation of $1-C^{14}$ -glycine into the proteins of brain cortex slices has been studied in vitro. No difference has been found between brain cortex slices from normal and hypoxic rats. The incorporation of glycine into brain proteins is enhanced, when the slices are incubated in oxygen, only if glucose is present in the medium. The implications of this fact are discussed in relation with the findings of experiments with liver and kidney slices.

1261

Milan U. Lab. of Physiology (Italy).

CHANGES IN ELEMENTARY NEURON ACTIVITY PRODUCED BY SOME NEUROTROPIC DRUGS, by R. Margaria, T. Gualtierotti and others. [1959] [19]p. incl. diagrs. tables, refs. (AFOSR-TN-59-637) (AF 61(514)-637) AD 225173 Unclassified

Presented at Symposium on Aeronaut. Preventive Med., Washington, D. C., Nov. 1957.

Also published in *Exper. Med. and Surg.*, v. 17: 46-64, Mar. 1959.

A number of neurotropic drugs were tested in man, and their effects on (a) the spinal delay in an oligosynaptic reflex, (b) neuromuscular plate delay, (c) sensory and motor fiber conduction speed, and (d) the activity of Renshaw reverberating circuit, were studied. Conduction speed both in sensory and motor fibers is remarkably constant and hardly influenced by most drugs. On the contrary spinal delay is increased after administration of acetylcholine, adrenaline, curare-like substances, ethanol and others: it is increased after atropine, chlorpromazine and caffeine. End-plate delay changes generally in the same direction as spinal delay. Renshaw inhibition is increased by atropine, chlorpromazine, ethanol, ritualin and diogenal: it is decreased by adrenaline, acetylcholine, caffeine and probably by curare-like substances. The changes induced by these

drugs in the elementary functional activities studied may suggest their application in counteracting the effects of some stress-inducing conditions. (Contractor's abstract)

1262

Milan U. Lab. of Physiology (Italy).

[REGULATION OF THE SPINAL MOTOR NEURON DISCHARGE RHYTHM OF THE RENSHAW SUPPRESSION PHENOMENON] Regolazione del ritmo di scarica del motoneurone spinale per mezzo dell'inibizione antidromica di Renshaw, by T. Gualtierotti, D. Spinelli, and A. Firoentini. [1958] [5]p. incl. illus. diagr. (AFOSR-TN-59-376) (AF 61(052)23) Unclassified

Also published in *Rend. Accad. Naz. Lincei, Series VIII*, v. 24: 744-748, June 1958.

The Renshaw phenomenon is considered to be explicable from the bases of various experimental conditions, such as in hypoglycemia. The action potential of a single muscle fiber during a voluntary isometric contraction in man records the amplitude as a mono-synaptic reflex response which is calculated from the Renshaw suppression phenomenon obtained from the same individual in normal and hypoglycemic conditions. The hypothesis made predicts the dependence of the discharge rhythm of the motor neuron upon the duration of the Renshaw inhibition, on the basis of a motor neuron discharge rhythm variation due to the hypoglycemia of the same order of magnitude as the Renshaw suppression phenomenon.

1263

Milan U. Lab. of Physiology (Italy).

[ROTATORY AND POSTROTATORY CEREBELLAR RESPONSES AND NUCAL NYSTAGMUS OF THE PIGEON] Risposte rotatorie e postrotatorie cerebellari e nistagmo nucale del piccione, by T. Gualtierotti and D. Passerini. [1958] [5]p. incl. illus. (AFOSR-TN-59-377) (AF 61(052)23) Unclassified

Also published in *Rend. Accad. Naz. Lincei, Series VIII*, v. 25: 219-223, Sept.-Oct. 1958.

The electric potentials of the cerebellum, of the neck muscles, and the centripetal and tangential accelerations are the three investigations made. The first study records the rotatory and post-rotatory electrical response of the cerebellum for an animal curarized intravenously with succinylcholine, 1 mg/kg immediately after rotation. There is no muscular response, such as could be expected after curarizing, and the agreement of the rotatory and postrotatory responses with the characteristics is found. The second study registered the rotatory and post-rotatory responses in a normal pigeon subjected to a centripetal acceleration so as to obtain a prolonged nystagmus. The rhythmic muscular discharges are of large amplitude and are

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formed of rhythmic potential sequences at a frequency of around 3-4/sec. It is found that the discharges of the nuchal muscles, expression of nystagmus, persists after ending the rotation although no posthumous cerebellar discharge is recorded. The third study records simultaneously the rotatory and post-rotatory cerebellar and muscular responses in the homing pigeon, while varying the rotational velocity. The purpose is to establish the identity or difference of the threshold between the nystagmus and the posthumous cerebellar responses. The results show the posthumous cerebellar discharges have a lower threshold than that for the nystagmus.

1264

Milan U. Lab. of Physiology (Italy).

[CEREBELLAR THRESHOLD AT ROTATORY ACCELERATIONS AND TEMPORAL SUMMATION IN THE HOMING PIGEON] Soglia cerebellare alle accelerazioni rotatorie e sommazione temporale nel piccione viaggiatore, by T. Gualtierotti and D. Passerini. [1958] [4]p. incl. illus. (AFOSR-TN-59-378) (AF 61(052)23)

Unclassified

Also published in Rend. Accad. Naz. Lincei, Series VIII, v. 25: 115-118, July-Aug. 1958.

A pigeon flying in a north-south direction, makes a lateral movement of the head through an extension of 7° to the velocity of 20 cm/sec, 2 cm being the distance between the labyrinth and the center of rotation of the head. The largest Coriolis acceleration is at the equator and is 3.21×10^{-6} g, at the forty-fifth parallel, the variation will only be 1×10^{-6} g. These data show that the hypothesis is unlikely that the sense of direction of migratory species is based on the physiological detail of such small differences in acceleration influencing the threshold. The data show that the sensibility to the rotatory solicitation is rather elevated in the homing pigeon and the duration of the rotation and the temporal summation increase such sensibility. The threshold values for the rotatory excitation are around 10^{-3} g, rather larger than the values necessary to raise the geodetic forces mentioned. Experiments are being conducted to determine the relative strengths of geodetic forces in comparison to temperature variations which also can cause excitations in the semicircular canals.

1265

Milan U. Lab. of Physiology (Italy).

[MODIFICATIONS INDUCED BY CURARE ON THE LOWER SPINAL NEURON ACTIVITY IN MAN] Modificazioni indotte dai curari sulla attività dei bassi

neuroni spinali nell'uomo, by D. Spinelli, T. Gualtierotti, and C. Morpurgo. [1958] 12p. incl. illus. refs. (AFOSR-TN-59-379) [AF 61(052)23] AD 219582
Unclassified

Presented at Simposio Internazionale su Curaro Curarosimili e Curarizzanti, Venice (Italy), Sept. 12-15, 1958.

Substances with curarizing action (Succinylcholine, d-Tubocurarine, Decamethonium) show a prompt effect on the spinal cord, even when introduced intravenously; therefore the hemato-liquoral and the perisynaptic barriers are not very efficient against these drugs. Any substance acting on the neuromuscular junction shows a similar effect on the synapsis between the recurrent fiber and the Renshaw cell, which belongs to the antidromic inhibitory circuit. The convulsive effects of the curarizing substances (muscle relaxants) directly introduced into the ventricles or in the spinal cord of the animal may be interpreted by supposing that they block the inhibitory circuit, leaving the facilitating circuits unbalanced. It is also possible that some other collateral effects attributed to these substances are partly due to a direct central action. The hypothesis is put forward that the effect of the curarizing drugs on the spinal motor neurone is not only localized on the cellular body, but may be transmitted along the nerve fiber to its termination. In fact, even in that portion of the nerve fiber, placed beyond the tourniquet applied to the limb, and therefore not affected by the drug, the same kind of alterations in the excitability occur, as seen in the cellular body. (Contractor's abstract)

1266

Milan U. Lab. of Physiology (Italy).

[CEREBELLAR ROTATORY AND POST-ROTATORY RESPONSES AND ARTERIAL PRESSURE VARIATIONS IN THE CAT CURARIZED WITH D-TUBOCURARINE AND WITH SUCCINYLCHOLINE] Risposte rotatorie e post-rotatorie cerebellari e variazioni della pressione arteriosa nel gatto curarizzato con d-tubocurarina e con succinilcolina, by T. Gualtierotti and D. Passerini. [1958] [6]p. incl. illus. (AFOSR-TN-59-494) (AF 61(052)23)
Unclassified

Also published in Rend. Accad. Naz. Lincei, Series VIII, v. 25: 584-589, Dec. 1958.

Experiments are carried out registering the electrocerebellogram from various points of the cerebellar cortex of the curarized cat, during and after rotatory solicitations of various entity. The animal was anaesthetized by ether and nitrogen peroxide through the exposure of that section of the cerebellar cortex and was heavily curarized. Graphs are shown giving the cerebellar electrical activity registered by the left flocculo-nodule, the posterior lobe and arterial pressure on the femur. Graphs show electromyograms of the dorsal muscles, electrocerebellograms and transversally registered tangential acceleration. The results confirm high cerebellar

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sensitivity to acceleration. The rotatory and post-rotatory electrical result is limited to the region of the flocculo-nodule. The cerebellar activity shows both amplitude increase and frequency diminution. The cerebral cortex responds typically to the afferent impulses, and with elevated strength when the stimuli stem from the labyrinth. The posthumous effect, constituted by 2 post-rotatory discharges is related to the receptor system of the semicircular canals.

1267

Milan U. Lab. of Physiology (Italy).

[THRESHOLD DETERMINATION OF THE CEREBELLAR ROTATORY RESPONSES OF THE FLOCCULO-NODULE OF THE CURARIZED CAT] Determinazione della soglia delle risposte rotatorie cerebellari dal flocculo-nodulo del gatto curarizzato, by T. Gualtierotti and D. Passerini. [1959] [4]p. incl. illus. (AFOSR-TN-59-654) (AF 61(052)23) Unclassified

Also published in Rend. Accad. Naz. Lincei, Series VIII, v. 26: 79-82, Jan. 1959.

The registration of the cerebellar potential was made only in the region of the flocculo-nodule, at the same time as the electromyogram of the dorsal muscles. The centripetal and tangential accelerations due to the rotary motion were recorded, total paralysis was affected by d-tubocurarine (10 u/kg) but modal amplitude muscular discharges were registered during the rotation. The results confirmed the high sensitivity of the flocculo-nodule of the cerebellum to this stimuli elicited from this vestibule as a consequence of rotary stimuli. The cerebellar cortex appears to be subordinated to continuous stimuli, of labyrinthine origin relative to spontaneous spatial relationship movements. A continuous modulation of the amplitude of the cerebellar activity is noticeable, for example, in maintaining an erect position.

1268

Milan U. Lab. of Physiology (Italy).

[VARIABILITY OF SOME ELEMENTARY FUNCTIONAL CHARACTERS OF THE CENTRAL NERVOUS SYSTEM FOUND IN MAN] Variabilità di alcuni caratteri funzionali elementari del sistema nervoso centrale rilevati nell'uomo, by L. Gallitelli and T. Gualtierotti. [1959] [4]p. incl. diagr. (AFOSR-TN-59-655) (AF 61(052)-23) Unclassified

Also published in Rend. Accad. Naz. Lincei, Series VIII, v. 26: 83-86, Jan. 1959.

Experiments determine the normal variability of the conduction velocity of the sensitive fibers, of the spinal time, of the plate retardation, and of the antidromic inhibition of the motoneurons. Results show the standard deviation of this impulse velocity in the sensory (75

msec) or motor (64 msec) through stimuli having a duration of either 0.1 msec, or 1 msec, and of ± 0.01 msec, of the same magnitude of measurement error. The parameters of the monosynaptic reflex, determined with stimuli applied at the popliteal and gluteal fold levels of the sciatic nerve, show a very significant constant in the normal individual. The characteristic of antidromic inhibition confirm the importance of experimentally or pathologically induced elementary functional modifications of the spinal centers.

1269

Minnesota U., Minneapolis.

AN ANALYTIC PROBLEM WHOSE SOLUTION FOLLOWS FROM A SIMPLE ALGEBRAIC IDENTITY, by G. Baxter. June 1, 1959, 24p. (Technical rept. no. 8) (AFOSR-TN-59-592) (AF 18(603)30) AD 229241; PB 143956 Unclassified

Also published in Pacific Jour. Math., v. 10: 731-742, 1960.

The solution of a particular operator equation involving elements in a Banach algebra is shown to follow directly from an algebraic identity involving the operator. A combinatorial lemma of a rather general nature is proved and then used to show the result above. Applications to probability theory, etc. are considered. (Contractor's abstract)

1270

Minnesota U., Minneapolis.

A TWO-DIMENSIONAL OPERATOR IDENTITY WITH APPLICATION TO THE CHANGE OF SIGN IN SUMS OF RANDOM VARIABLES, by G. Baxter. July 1, 1959 [20]p. (Technical note no. 9) (AFOSR-TN-59-691) (AF 18-603)30) AD 226551 Unclassified

Also published in Trans. Amer. Math. Soc., v. 96: 210-221, Aug. 1960.

Let $\{X_k\}$ be a sequence of independent, identically distributed random variables and let $S_0 = 0$; $S_1 = X_1, \dots, S_n = X_1 + \dots + X_n$. A certain matrix factorization is shown to be related to the number of changes of sign among S_0, S_1, \dots, S_n . The results are treated as statements about operators in Banach algebras. Two examples are considered; the symmetric exponential distribution and the Bernoulli variable case. (Contractor's abstract)

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Minnesota U., Minneapolis.

A FAMILY OF INTEGRALS SERVING TO CONNECT THE WIENER AND FEYNMAN INTEGRALS, by R. H. Cameron. Nov. 23, 1959 [24]p. (Technical note no. 12) (AFOSR-TN-59-1272) (AF 18(603)30) AD 232804; PB 146440 Unclassified

Also published in Jour. Math. Phys., v. 39: 126-140, July 1960.

A sequential definition is given of a family of integrals depending on a variance parameter σ^2 . If σ^2 is real this reduces, under reasonable conditions, to the ordinary Wiener integral. If σ^2 is pure imaginary, the integral can be considered as a Feynman integral. For certain analytic functionals, the Feynman integral is shown to be reduced to an ordinary Wiener integral. (Contractor's abstract)

1272

Minnesota U., Minneapolis.

INITIAL-PERMEABILITY SPECTRA OF MICROSCOPIC IRON-OXIDE PARTICLES, by W. F. Brown, Jr., J. P. Hanton, and A. H. Morrish. Oct. 1959 [8]p. incl. diagr. table. (AFOSR-TN-59-759) (AF 18(603)-113) AD 227263; PB 143988 Unclassified

Presented at meeting on Magnetism and Magnetic Materials, Detroit, Mich., Nov. 16-19, 1959.

Also published in Jour. Appl. Phys., v. 31: 214S-215S, May 1960.

The magnetic resonance of single-domain ferromagnetic particles in zero applied steady magnetic field is studied theoretically and experimentally. The axial ratio of the powder particles deduced from the resonance measurements agrees reasonably well with optical data. This is strong evidence regarding the origin of the observed resonance. (Contractor's abstract)

1273

Minnesota U., Minneapolis.

NATURAL AND INDUCED SPECTRA OF SOME FERRITES, by D. B. Eonstrom, J. P. Hanton, and A. H. Morrish. Nov. 1959 [32]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1128) (AF 18(603)113) AD 229420; PB 144868 Unclassified

The natural magnetic spectra refers to the variation of the complex initial permeability ($\mu = \mu_1 - i\mu_2$) of some ferrites as a function of frequency. Two ferrite materials, magnetite (Fe_3O_4) and gamma ferric oxide

($\gamma\text{-Fe}_2\text{O}_3$) were investigated over the frequency range 0 - 10 kmc/sec. Only 1 resonance in the μ_2 curves

was observed; the frequency at which the maximum occurred was found to depend on the shape and size distribution of the particles in the powders. The induced magnetic spectra refers to the study of the permeability of a ferrite at a certain frequency, in this case 24 kmc/sec, in steady fields in the range 0 - 10 kilooersteds. Detailed investigations were made of some single crystals of magnetite at temperatures from 2-125°K. Magnetite undergoes a phase transition from a spinel to an orthorhombic structure at about 119°K. A magnetic field applied as the crystal is cooled through this temperature selects the orthorhombic c-axis. However, the a and b axes have 2 possible orientations, and, as a result, the crystal is twinned. This twinning was positively identified by a study of the magnetic resonances. The detwinning action of an applied field extinguishes certain resonances. (Contractor's abstract)

1274

Minnesota U. [Dept. of Aeronautical Engineering] Minneapolis.

INITIALLY WARPED SANDWICH PANEL UNDER COMBINED LOADINGS, by C. C. Chang and B. T. Fang. Aug. 16, 1959 [9]p. incl. diagrs. refs. (AF 18(603)112) AD 249009 Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 779-787, Oct. 1960.

Based on small deflection theory, differential equations for the elastic bending of an orthotropic weak-core sandwich panel with small initial warping are derived by the variational energy method. The applied loads consist of arbitrarily distributed transverse loads and eccentrically applied edge loads and/or edge moments. For the case of a simply supported rectangular panel, solutions of the differential equations are obtained in the form of double Fourier series. As a practical example, numerical values of the maximum stresses and deflections for a square sandwich panel are calculated and presented in the form of graphs. A simple design criterion is suggested for considering approximately the effect of initial warping and transverse pressure. The method is particularly useful for preliminary design. (Contractor's abstract)

1275

Minnesota U. [Dept. of Mathematics] Minneapolis.

CHANGE OF TIME SCALE FOR MARKOV PROCESSES, by S. Orey. Sept. 1, 1959 [21]p. (AFOSR-TN-59-1067) (AF 49(638)617) AD 243767; PB 144771

Unclassified

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Also published in Trans. Amer. Math. Soc., v. 99: 384-397, June 1961.

Let $\{X_n\}$ be a recurrent Markov chain, $n = 0, 1, \dots$. A new process $\{\tilde{X}_t\}$, $0 \leq t < \infty$ is obtained from the original process by requiring a wait of duration $\nu(x)$ after reaching x , for every state x , where $\nu(x) > 0$. Let $\tilde{X}_t = (\tilde{X}_t, Y_t)$, where Y_t is the elapsed time since the last transition. $\{\tilde{X}_t\}$ is a Markov process; Y_t is a generalized renewal process. Results are obtained about the structure of the \tilde{X}_t - process and the asymptotic behavior of the transition probabilities. The case in which the waiting times are random variables is also treated. (Contractor's abstract)

1276

Minnesota U. [Heat Transfer Lab.] Minneapolis.

THE APPLICATION OF CONSTANT PROPERTY SOLUTIONS TO MASS TRANSFER COOLING CALCULATIONS, by C. J. Scott. Dec. 1958 [48]p. incl. diagrs. refs. (Engineering memo. no. 76) (AFOSR-TN-59-201) (AF 18(600)1226) AD 211527; PB 140425

Unclassified

Simple transformation relations are developed for applying the results of constant property laminar and turbulent boundary layer solutions to the calculation of mass transfer cooling problems using foreign gas effusion. The methods are similar to those developed by Eckert for solid surface predictions. Laminar constant pressure, laminar stagnation, and turbulent constant pressure flows are studied. A reference concentration of 4/10 of the wall concentration was used in evaluating the properties. Comparisons are made with currently available exact theoretical solutions in order to assess the value of the method as a means for extrapolating to conditions not covered by the available solutions. (Contractor's abstract, modified)

1277

Minnesota U. [Heat Transfer Lab.] Minneapolis.

INTEGRAL LAMINAR BOUNDARY LAYER SOLUTIONS USING THE CROCCO VARIABLES, by C. J. Scott. Aug. 1959 [19]p. incl. diagrs. table. refs. (Engineering memo. no. 86) (AFOSR-TN-59-1304) (AF 18(600)1226) AD 231973; PB 145775

Unclassified

An analysis is presented which predicts the skin friction and surface heat transfer characteristics of a compressible laminar boundary layer. The present formulation is restricted to constant specific heat and Prandtl number and a linear variation of fluid viscosity with temperature. Regions where the analysis may be extended are pointed out. For the injection cases considered, the coolant gas is considered to be identical

to the main stream fluid. Numerical examples are presented for constant pressure, impermeable and permeable surfaces, with upstream and downstream transpiration cooling and strip injection. Surface temperature distributions are presented for the case of constant surface injection with uniform reservoir temperature. In the cases where similarity exists, the method is tested by comparisons with exact solutions which are free from the limitations of the present analysis. (Contractor's abstract)

1278

Minnesota U. [Heat Transfer Lab.] Minneapolis.

LAMINAR, TRANSITIONAL AND TURBULENT MASS TRANSFER COOLING EXPERIMENTS AT MACH NUMBERS FROM 3 TO 5, by C. J. Scott, G. E. Anderson, and D. R. Elgin. Aug. 1959 [30]p. incl. illus. diagrs. (Research rept. no. 162) (AFOSR-TN-59-1305) (AF 18(600)1226) AD 231974; PB 145760

Unclassified

A summary is presented of the experimental research work on porous-wall mass transfer cooling effects. Two coolants, air and helium, were included in all of the investigations. Laminar, transitional, and turbulent boundary layers on constant pressure surfaces were investigated, using flat plates and cones. A porous hemisphere was used to examine the effect of non-uniform surface pressure. The experimental results covering relatively-low temperatures and low speed confirm analytical boundary layer predictions on the relative effectiveness of the 2 gases in reducing heat transfer although quantitative agreement does not exist. The available theories do not correctly indicate the general trends of experimental temperature recovery factors. Transition Reynolds number decreases, caused by injection, could be overcome by the cooling made possible by the injection process. Both laminar and turbulent boundary layers could be blown-off the bodies by excessive coolant injection. (Contractor's abstract)

1279

Minnesota U. [Heat Transfer Lab.] Minneapolis.

MASS TRANSFER COOLING EXPERIMENTS ON A HEMISPHERE AT $M = 5$, by G. E. Anderson, C. J. Scott, and D. R. Elgin. Aug. 1959 [20]p. incl. illus. diagrs. table. refs. (Research rept. no. 166) (AFOSR-TN-59-1306) (AF 18(600)1226) AD 231975; PB 145788

Unclassified

A segmented, porous hemisphere was designed and constructed to provide a constant temperature surface with helium mass transfer cooling. The variation of surface heat transfer with helium injection rate and with position on the hemisphere surface was measured. The data is presented along with available analytical results. (Contractor's abstract)

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Minnesota U. Hormel Inst., Austin.

SYNTHESES OF UNSATURATED FATTY ALDEHYDES, by H. K. Mangold. [1958] [3]p (AFOSR-TN-59-283) (AF 18(603)18) AD 254336 Unclassified

Also published in Jour. Org. Chem., v. 24: 405-407, Mar. 1959.

Oleyl-, linoleyl-, and linolenyl-aldehydes were prepared by a modified Grundmann synthesis. The procedure can be used for the preparation of radioactive aldehydes on a mg scale. (Contractor's abstract)

1281

Minnesota U. Hormel Inst., Austin.

INCLUSION COMPLEXES IN SOLUTION, by H. Schlenk. Technical rept. Feb. 1, 1956-Dec. 31, 1957, 27p. incl. diagrs. tables, refs. (AFOSR-TR-59-30) (AF 18(603)-18) AD 212924; PB 140216 Unclassified

Association of α - and β -cyclodextrin with several organic acids in aqueous solution has been studied by measuring solubilities. Molecule fitting into the dextrin rings are solubilized while bulky molecules are only slightly, if at all, affected by the presence of dextrans. The solubilization factors, the concentration of solubilized acids, and of dextrin, which have been found in systems saturated with both hydrated complex and fatty acid, indicate that the stabilities of complexes follow an irregular pattern. The different ring sizes of α - and β -cyclodextrin are reflected in the values obtained for the component ratios in solution and the solubilization factors. Unsaturated or rigid molecules associate strongly with cyclodextrins in solution, but they yield crystalline complexes only with difficulty. Cyclodextrins protect to some extent benzoic acid from the salting-out effect of halogen ions. The normal order of salting-out constants, $\text{Cl}^- > \text{Br}^- > \text{I}^-$, is reversed when related to complexes. I^- has particular affinity for α -cyclodextrin, so diminishing its association with benzoic acid. The stoichiometry of dehydrated inclusion complexes of fatty acids follows the principle of preferential placing. The rate of the reaction of periodate with α -cyclodextrin is lowered when the latter is associated with guest molecules. The optical rotation of cyclodextrin in solution is increased by the presence of unsaturated molecules, while it is decreased when the cosolutes are saturated flexible molecules.

1282

Minnesota U. [Inst. of Tech.] Minneapolis.

ON THE STABILITY OF VISCOUS FLUID MOTIONS, by J. Serrin. [1959] 13p. incl. diagrs. refs. (AFOSR-TN-59-77) (AF 49(638)262) AD 210137

Unclassified

Also published in Arch. Rational Mech. and Anal., v. 3: 1-13, 1959.

Investigation is made of one aspect of the classical problem of hydrodynamical stability, i.e., the determination of sufficient conditions for a basic flow of an incompressible fluid to be stable under arbitrary disturbances. The method of energy was used to establish a Reynolds number criterion for the stability of an arbitrary fluid motion in a bounded region. Similar criteria were obtained for the stability of flows in unbounded regions and applied to the problem of uniqueness of steady flow. A general variation problem connected with the stability of an arbitrary motion is stated, as well as a particular example, the laminar Couette flow between rotating coaxial cylinder.

1283

Minnesota U. [Inst. of Tech.] Minneapolis.

A NOTE ON THE EXISTENCE OF PERIODIC SOLUTIONS OF THE NAVIER-STOKES EQUATIONS, by J. Serrin. [1959] [3]p. (AFOSR-TN-59-78) (AF 49(538)-262) AD 210138 Unclassified

Also published in Arch. Rational Mech. and Anal., v. 3: 120-122, 1959.

Proof is presented for the existence of stable periodic solutions of the Navier-Stokes equations. Let \mathcal{V} be a bounded region in space, and let a flow velocity be prescribed at each point of the boundary of \mathcal{V} . Assume furthermore that both \mathcal{V} and the assigned velocities depend periodically on the time t . Consider that (1) to every continuous initial distribution of velocities over \mathcal{V} there corresponds a solution of the Navier-Stokes equations satisfying the prescribed boundary conditions and (2) there is one solution whose Reynolds number $\text{Re} = V d / \nu$ is less than 5.7, where V is the max speed of the flow during the whole time interval $0 \leq t < \infty$, d is the max diam of \mathcal{V} , and ν is the kinematic viscosity (this solution is equicontinuous in $\mathcal{X} = (x, y, z)$ for all t). Then, under conditions 1 and 2 there exists a unique, stable, periodic solution of the Navier-Stokes equations in \mathcal{V} which takes on the prescribed velocities on the boundary of \mathcal{V} .

1284

Minnesota U. [Inst. of Tech.] Minneapolis.

ON THE UNIQUENESS OF COMPRESSIBLE FLUID MOTIONS, by J. Serrin. [1959] [18]p. incl. diagr. (AFOSR-TN-59-205) (AF 49(638)262) AD 211659 Unclassified

Also published in Arch. Rational Mech. and Anal., v. 3: 271-288, 1959.

A study was made of the initial value problem for compressible fluid flow, with particular emphasis on the

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uniqueness of its solutions. Proof is presented of theorems which assert that fluid motion in a bounded region $V = V(t)$ is uniquely determined by its initial velocity, temperature, and density distribution together with certain boundary conditions. The form of the boundary conditions is especially interesting for non-viscous, non-heat conducting fluids, it having been found that such conditions are superfluous at any point where the fluid is leaving V at a relatively supersonic speed. This result is closely associated with the existence of characteristic manifolds in the flow regions, and permits proof for spatial flows of a theorem of the type given by Courant and Friedrichs for 1-dimensional motions.

1285

Minnesota U. [Inst. of Tech.] Minneapolis.

THE EXTERIOR DIRICHLET PROBLEM FOR SECOND ORDER ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS, by N. Meyers and J. Serrin. [1959] [26]p. incl. diagrs. (AFOSR-TN-59-1251) (AF 49(638)262) AD 249929 Unclassified

Also published in Jour. Math. and Mech., v. 9: 513-538, July 1960.

This paper contains a careful and lucid analysis of the behavior of solutions of 2nd order elliptic equations, which are defined in a neighborhood \mathcal{E} of infinity in $n \geq 2$ dimensions, and which assume prescribed boundary data on an inner boundary. The exterior Dirichlet problem is defined as follows: Let \mathcal{E} be a given open region in the Euclidean number space E^n , containing a neighborhood of infinity and having a smooth internal boundary $F\mathcal{E}$. A continuous function $\varphi(x)$ is prescribed on $F\mathcal{E}$. The function $u = u(x)$ is sought, which is of class C^2 and satisfies $Lu = f$ in \mathcal{E} , and which continuously takes on the values $\varphi(x)$ on the boundary $F\mathcal{E}$. Two different cases are considered: (1) the function u shall tend to an assigned limit l as x tends to infinity, and (2) the function u shall be bounded in \mathcal{E} . It is shown that problem 1 is well-set, (that is for any assigned data there exists exactly 1 corresponding solution) if and only if there exists a barrier at infinity. Problem 2 is found to be well-set for an equation of the form $Au = a, u_{ik} u_{ik} = 0$, if and only if the equation enjoys an extended maximum principle.

1286

Minnesota U. [Inst. of Tech.] Minneapolis.

A NEW DEFINITION OF THE INTEGRAL FOR NON-PARAMETRIC PROBLEMS IN THE CALCULUS OF VARIATIONS, by J. Serrin. [1959] [10]p. (AFOSR-3844) (AF 49(638)262) Unclassified

Also published in Acta Math., v. 102: 23-32, 1959.

This study is largely concerned with the statement assuming that an extremal $u_0(x,y)$, taking the preassigned values on the boundary, gives the minimum for a double nonparametric integral of the calculus of variations $I[u] = (R) \int F(x, y, u, p, q) dx dy$ in a large class of admissible functions $u(x,y)$, if $u_0(x,y)$ can be imbedded in a field of extremals. R denotes an open bounded region of the xy -plane, and F a continuous function of x, y, u, p, q for $(x,y) \in R, u, p, q$ real, $F(x, y, u, p, q) \geq 0$, satisfying the regularity condition $E(x, y, u, p, q, P, Q) \geq 0$, where E denotes the usual Weierstrass function. The following are proven: (1) For non-negative regular integrands $F(x, y, p, q)$ independent of u , if the class A , or A^* , is not empty, and $u(x,y)$ is an extremal satisfying the condition, $u(x,y)$ is continuous on $\bar{R} = R \cup R^*$ and takes on the boundary R^* of R preassigned in R , then $u \in A$, or $\in A^*$, and u gives the minimum of $I[u]$ in A or A^* . (2) For "tame" integrands $F(x, y, p, q)$ if $u(x,y)$ gives the minimum of $I[u]$ in the class A or A^* , then u is of class C^2 in R . (3) For non-negative regular integrands $F(x, y, u, p, q)$, if an extremal $u(x,y)$, $(x,y) \in R$, satisfying the condition in 1 above, and the condition, $I[u] < \infty$, and is an element of a field V of extremals over R , then u gives the minimum of $I[u]$ in the class A^* .

1287

Minnesota U. Rosemount Aeronautical Labs., Minneapolis.

BLUFF-BODY FLAME STABILIZATION AT LOW PRESSURES, by C. C. Chang, G. Engholm, and L. H. Zacho. July 1959, 55p. incl. illus. diagrs. tables, refs. (Research rept. no. 161) (AFOSR-TR-59-111) (AF 18(600)-1553) AD 226869; PB 144346 Unclassified

Presented at Sixth Tech. Conf. of Rosemount Aeronaut. Labs., Minnesota U., Minneapolis, 1959.

Blowoff velocities of butane-air flames stabilized on a 3/16 in. diameter cylindrical flameholder were measured as a function of pressure (1/10 to 1 atm) and equivalence ratio for Reynolds numbers ranging from 1945 to 4685. Within this laminar range it was found that blowoff velocity was directly proportional to pressure for equivalence ratios from 0.9 to 1.5 and inversely proportional to pressure for equivalence ratios less than 0.9 or greater than 1.5. (Contractor's abstract)

1288

Minnesota U. School of Chemistry, Minneapolis.

SPIN RESONANCE STUDIES OF DEFECTS IN MAGNESIUM OXIDE, by J. E. Wertz, P. Auzins and others. [1959] [6]p. incl. diagr. refs. (AFOSR-3588) (In cooperation with Clarendon Lab., Oxford (Gt. Brit.)) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)479 and Atomic Energy Research Establishment) AD 612229 Unclassified

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Also published in Faraday Soc. Discussions, No. 28: 136-141, 1959.

Excluding impurities, trapped holes are the most important defect centers which are observable by electron-spin resonance in presently-available magnesium oxide crystals. Models are suggested for 2 types of trapped hole centers. The 1st, involving 1 hole, is believed to involve the following linear array: hole trapped on an oxygen atom—positive ion vacancy—normal O^{2-} ion—trivalent impurity ion. The 2nd center, which is far less stable, involves 2 holes opposite another about a positive-ion vacancy. It is suggested that another defect is associated with this pair to cause localization of the axis of symmetry. These conclusions are drawn from electron-spin resonance spectra showing simple axial symmetry for single-hole centers lying along principal crystal axes. For hole-pair centers pairs of lines approximately centered upon the positions of the previously-mentioned axial lines are observed. More complex hole center spectra have also been observed. (Contractor's abstract)

1289

Minnesota U. School of Chemistry, Minneapolis.

ELECTRON TRANSFER AMONG TRANSITION ELEMENTS IN MAGNESIUM OXIDE, by J. E. Wertz, P. Auzins and others. [1958] [6]p. incl. diagr. tables, refs. (AFOSR-3589) (In cooperation with Clarendon Lab., Oxford (Gt. Brit.)) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-479 and Atomic Energy Research Establishment) AD 612230 Unclassified

Also published in Faraday Soc. Discussions, No. 26: 66-71, 1958.

This study is largely devoted to interpretation of the qualitative displacement of the equilibria $M^{2+} = M^{3+} + e$ when MgO is heated in vacuum, in oxygen or in metal vapors, or subjected to 4.9 ev or x-irradiation. Heating in vacuum at temperatures of 1200°C or higher, molecular oxygen is lost from the surface of MgO when the partial pressure of oxygen is less than the decomposition. The electrons left behind by the oxide ions are trapped by trivalent iron group ions, principally Fe^{3+} , though V^{3+} may also do so if the treatment is prolonged. It is thought that a Fe^{3+} ion located near a positive ion vacancy may acquire an electron from a neighboring oxygen ion, leaving a hole. The hole as well as the positive-ion vacancy will tend to move toward the surface, with the hole combining with an electron from the surface oxygen which is lost. In oxygen heating, oxygen is taken up by MgO at temperatures above 1000°C in amounts exceeding that required to form a chemisorbed layer. It is noted that the divalent ions tend to lose an electron and become trivalent. It is presumed that the transfer of electrons from divalent ions to oxygen on the surface pro-

ceeds by way of hole movement. The effects of x-irradiation and ultra-violet irradiation are discussed also. Under the former the existing equilibrium is upset in favor of Fe^{2+} , Cr^{3+} , V^{3+} , and e.

1290

Minnesota U. [School] of Chemistry, Minneapolis.

A MODIFICATION OF THE METHOD OF FLASH PHOTOLYSIS AND ITS APPLICATION TO THE STUDY OF LABILE INTERMEDIATES IN REACTIONS SENSITIZED BY COMPLEX MOLECULES, by R. Livingston. Final rept. Sept. 1, 1955-Mar. 31, 1959. Aug. 12, 1959, 11p. incl. diagrs. (AFOSR-TR-59-114) (AF 18(600)-1485) AD 225663; PB 143630 Unclassified

A modification of the flash photolytic technique was used in the study of spectroscopic properties and reactions of photochemically produced labile states of polyatomic molecules. In the modified technique a device was developed in which a single flash served to photolyze the solution and to expose 2 absorption spectra. The 1st one was exposed after passing through the activated solution, and the other i after passing through a similar cuvette filled with the solvent. Measurements were made of the spontaneous rate of decay of chlorophyll a in pyridine and cyclohexanol. The quenching of the triplet by quinone, O, β -carotene, luteol, and zeaxanthophyll was also studied. Results indicated that m-dinitrobenzene was an efficient quencher and that all trans retinene, like carotene, was a quencher of the triplet state of chlorophyll. Measurements were made of the half life and the quenching of the triplet state of anthracene.

1291

Missouri U. Dept. of Mathematics, Columbia.

UNSTABLE HOMEOMORPHISMS AND THE CLOSED 2-CELL, by J. P. Jakobsen and W. R. Utz. Aug. 1959 [14]p. (Technical rept. no. 12) (AFOSR-TN-59-855) (AF 18(600)1108) AD 226230; PB 144308 Unclassified

If X is a metric space with metric ρ and $T(X) = X$ is a self-homeomorphism of X, then T is said to be unstable provided there exists a $\delta > 0$ depending only upon X and T such that corresponding to each distinct pair $x, y \in X$ there exists an integer $n(x, y)$ for which $\rho(T^n(x), T^n(y)) > \delta$. Unstable homeomorphisms are shown not to exist for a closed 2-cell.

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Missouri U. Dept. of Mathematics, Columbia.

ON A THEOREM OF E. SPARRE ANDERSEN AND ITS

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APPLICATION TO TESTS AGAINST TREND, by H. D. Brunk. Aug. 1959, iv. incl. refs. (Technical rept. no. 13) (AFOSR-TN-59-856) (AF 18(600)1108) AD 225371; PB 144309 Unclassified

Let n be a positive integer, fixed throughout, and let X_1, \dots, X_n be random variables. Let $S_c = 0$, and $S_r = \sum_{i=1}^r X_i$, $r = 1, 2, \dots, n$. The lower part of the boundary of the convex hull of the set of points $\{(r, S_r)\}_{r=0}^n$ in the Cartesian plane is the greatest convex minorant (gcm) of this set of points. An extension is presented of Andersen's theorem which finds the distribution of the random variable M , the number of sides of the gcm, when the random variables X_1, \dots, X_n are symmetrically dependent, and which observes that it is the same distribution as that of the number of cycles in a randomly chosen permutation of the integers $1, 2, \dots, n$. A class of random variables sharing a common distribution are exhibited for which M and the number of cycles of a randomly chosen permutation are instances. Events describable in terms of the gcm are presented. Conditions are given under which the conditional probability $P(H/D^k)$ coincides with the probability $P[H(\alpha)]$. The likelihood ratio tests are described for H_0 against alternatives subject to H_1 , and of H_1 against all alternatives.

1293

Missouri U. [Dept. of Mathematics] Columbia.

BEST FIT TO A RANDOM VARIABLE BY A RANDOM VARIABLE MEASUREMENT WITH RESPECT TO A σ -LATTICE, by H. D. Brunk. [1959] [18]p. incl. refs. [Technical rept. no. 14] (AFOSR-TN-59-1134) (AF 18(600)1108) AD 230193; PB 145489 Unclassified

Also published in Pacific Jour. Math., v. 2: 785-802, 1961.

Let (Ω, S, μ) be a probability space for f a random variable, an S -measurable function from Ω into the space R of real numbers. Let S_0 be a sub- σ -algebra of S and let f be integrable. Then the Radon-Nikodym theorem yields a S_0 -measurable function g , which is the best fit to f . A function with the same minimizing properties is shown to correspond to f when an arbitrary sub- σ -lattice L takes the place of S_0 . The problem for square-integrable f is treated as a problem in Hilbert space. Results on the minimum problem for arbitrary classes of functions are obtained and used to yield the principal results for integrable f and for measurable f . Given a partial ordering on Ω , a σ -lattice L is shown to be introduced such that the L -measurable functions are precisely the order preserving functions. Application to the problem of maximum likelihood estimation of a multi-dimensional parameter is mentioned.

1294

Modena U. (Italy).

ELECTROCHEMICAL BEHAVIOR OF GRAPHITE ELECTRODES IN SOLUTIONS OF VARIOUS pH CONTAINING OXYGEN AND HYDROGEN PEROXIDE, by G. Bianchi, G. Caprioglio and others. Apr. 30, 1959 [40]p. incl. diagrs. (Technical scientific note no. 3) (AFOSR-TN-59-708) (AF 61(052)85) AD 219263; PB 143596 Unclassified

Polarization measurements with graphite electrodes were effected in solutions of different pH by circulating O_2 and CO_2 and varying the H_2O_2 concentration of the solutions from 0 to 10^{-1} M. Variations of potential with time at the moment of opening and closing the polarization circuit were also registered. The results were interpreted by considering the intervention of processes occurring on graphite, which, however, does not behave as an inert electrode with respect to O_2 and H_2O_2 processes. The intervention of the electrode is manifested under the form of processes presumably due to the presence of the superficial oxide $C(O)$ and to adsorbed carbonates $(CO_3^{--})_{ads}$. Such processes can substitute or superimpose those concerning H_2O_2 and O_2 particularly in the case of acid solutions.

1295

Modena U. (Italy).

INFLUENCE OF SURFACE PREPARATION OF PLATINUM ELECTRODES ON CATHODIC PROCESSES OF HYDROGEN PEROXIDE, by G. Bianchi and G. Caprioglio. Apr. 30, 1959 [4]p. incl. diagrs. tables. (Technical scientific note no. 1) (AFOSR-TN-59-732) (AF 61(052)-85) AD 219364 Unclassified

Also published in Electrochim. Acta, v. 1: 18-21, 1959.

Values of static tensions have been measured, and cathodic polarization curves have been plotted for platinum electrodes in H_2O_2 solutions at various pH values. The results depend upon the treatment of the platinum surface. Two different methods of surface preparation have been considered. With "bare" electrodes and with "oxidized" electrodes differences have been observed for static tensions and for slopes of polarization curves. (Contractor's abstract)

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Modena U. (Italy).

ANODIC BEHAVIOUR OF HYDROGEN PEROXIDE ON PLATINUM ELECTRODES, by G. Bianchi, G. Caprioglio

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and others. Apr. 30, 1959 [36]p. incl. diagrs. refs. (Technical scientific note no. 4) (AFOSR-TN-59-921) (AF 61(052)85) AD 226591 Unclassified

The evolution of O_2 from the acid solutions of H_2O_2 begins on platinum at low anodic tensions (+ 800 mv) due to probable intervention of the platinum oxides. At greater current densities, the process occurs in the same conditions as on other metals, e.g., gold, and probably requires the intervention of the adsorbed atomic O_2 . The reaction between H_2O_2 and adsorbed O_2 gives rise to the evolution of the O_2 . The adsorption and the formation of platinum oxides can explain the anodic phenomena of hysteresis. In alkaline solutions the oxidation of H_2O_2 occurs on platinum with the same mechanism as on other metals. At greater current densities the discharge of the ions OH^- and the formation on platinum of a film of adsorbed OH radicals can intervene. The radicals can react with H_2O_2 to give rise to the evolution of O_2 . (Contractor's abstract)

1287

Modena U. (Italy).

THE ELECTROCHEMICAL BEHAVIOR OF HYDROGEN AND OXYGEN MIXTURES ON PLATINUM ELECTRODES, by G. Bianchi and F. Mazza. Apr. 30, 1959 [7]p. incl. diagrs. (Technical scientific note no. 2) (AFOSR-TN-59-1156) (AF 61(052)85) AD 232054 Unclassified

Also published in *Electrochim. Acta*, v. 1: 198-204, 1959.

The electrochemical processes occurring when hydrogen and oxygen, dissolved in aqueous solution, combine on a platinum surface to give H_2O_2 and H_2O , and the anodic and cathodic partial processes of hydrogen oxidation and of oxygen reduction, have been investigated. The measured mixed potentials can be interpreted on the basis of the polarization curves for these partial processes. Hydrogen reduces hydrogen peroxide solutions and mixed potentials have been measured which can be interpreted on the basis of polarization curves for the partial processes of hydrogen oxidation and hydrogen peroxide reduction. In more concentrated hydrogen peroxide solutions ($10^{-2}M$) the mixed potentials always equal the potential for the process of hydrogen peroxide reduction. (Contractor's abstract)

1288

Modena U. (Italy).

BASIC RESEARCHES IN METAL CORROSION, by G. Bianchi. Final technical rept. Apr. 30, 1959, 10p. incl.

tables. (AFOSR-TR-59-76) (AF 61(052)85) AD 218368; PB 144122 Unclassified

The electrochemical processes of O_2 and H_2O_2 on platinum, graphite and gold electrodes were studied, to get a knowledge of the mechanism of oxygen corrosion. The nature of the cathode affects the cathodic processes of oxygen and hydrogen peroxide reduction in acid and neutral solutions; moreover the platinum, the graphite and the gold are absolutely different also from the point of view of their catalytic activity for the decomposition of hydrogen peroxide in acid solutions. The process of oxygen and hydrogen peroxide reduction in alkaline solutions takes place, independently of the nature of the cathode, at tensions very near the reversible one corresponding to the process: $O_2 + H^+ + 2e = HO_2^-$. (Contractor's abstract)

1299

Mount Zion Hospital, San Francisco, Calif.

STUDIES OF THE RELATIONSHIPS BETWEEN NEUROPHYSIOLOGICAL AND BEHAVIORAL PROCESSES IN MAN, by B. Feinstein and M. Berke. Final rept. Apr. 1, 1956-June 30, 1958. July 17, 1959 [47]p. incl. illus. diagrs. refs. appendices. (AFOSR-TR-59-58) (AF 18(603)48) AD 216107; PB 143356 Unclassified

A series of experiments on cerebral electrophysiology are reported. A brief description of the laboratory apparatus is given. The description of development of both instrumentation and surgical techniques may be found in the 4 technical reports which are included in this report. A Stereotaxic Technique in Man Allowing Multiple Spatial and Temporal Approaches to Intracranial Targets, by B. Feinstein, W. W. Alberts and others (*Jour. Neurosurgery*, v. 17: 708-720, 1960; AFOSR-TN-60-1456) describes a method of intracranial localization by precise stereotaxic means. This localization procedure includes radiographic positioning and interpretation of this data for proper orientation of the stereotaxic instrument on the target. A method which allows return to this site without relocating is also described. A Stimulus Pulse Polarity Reversal Unit, by W. W. Alberts (MZH.02:001, Vol. II) describes a simple means of obtaining a brain stimulus waveform which passes a current pulse, first in one direction and then an equal pulse in the other, from a single laboratory stimulator. Implanted Electrodes (unpublished) discusses the multi-lead electrodes which were designed for this experiment. Preliminary results with stimulation by these electrodes and the responses elicited are presented. Sensory Perception by Direct Stimulation of Human Cerebral Cortex: Stimulus Parameters, by B. Libet, W. W. Alberts and others (*Fed. Proc.*, v. 18: 92, Mar. 1959) presents an analysis of the adequacy of electrical stimuli to the somatosensory area for eliciting a sensation. Comparisons of stimuli and responses are also discussed.

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Naples U. [Inst. of Aeronautics] (Italy).

LAMINAR MIXING OF STREAMS OF DIFFERENT GASES, by L. G. Napolitano and A. Pozzi. Apr. 1959 [70]p. incl. diagrs. tables, refs. (Technical note no. 1; I.A. rept. no. 10) (AFOSR-TN-59-977) (AF 61(052)160) AD 226469; PB 143911 Unclassified

Solutions of plane, isobaric, laminar mixing of 2 streams of different gases are presented. For the case of isovel mixing an exact, closed form solution is derived for the general case of Lewis number (Le) different from one. With the help of this exact solution it is shown that the assumption $Le = 1$ may lead to substantial errors in the temperature profiles which are already of the order of 10% when the Lewis numbers of the 2 streams are around $1.10 + 1.20$. An approximate method of solution, based on the integral method, is presented for the general case without the limitations of constant Schmidt number and constant ($\rho\mu$). The solution by this method proves to be simple and immediate. The accuracy of the method is determined by comparison with the previously mentioned closed-form solution and with numerical solutions obtained by means of high-speed computing machine for a number of indicative cases. The comparison shows that velocity profiles and concentration profiles are accurate to within few percent throughout the ranges of practical interest of the parameters entering the problem. (Contractor's abstract)

1301

Naples U. [Inst. of Theoretical Physics] (Italy).

A SYSTEM OF COUPLED OSCILLATORS AS A FUNCTIONAL MODEL OF NEURONAL ASSEMBLIES, by V. Braitenberg, E. R. Caianiello and others. Nov. 1958, 6p. (Scientific note no. 1) (AFOSR-TN-59-470) (AF 61(052)96) AD 215229; PB 142142 Unclassified

Some points are presented in a purely qualitative and non-mathematical form which are considered to be relevant to the problems posed by the interpretation of nervous functions. The basic principles are outlined on which a theory can be founded and models are built to imitate the functions of the nervous system. This model promises to share with the living nervous system the properties of economy, capacity to recognize similarity, and character of wholeness (Gestalt).

1302

Naples U. [Inst. of Theoretical Physics] (Italy).

THE CEREBELLAR CORTEX AS A TIMING ORGAN. DISCUSSION OF A HYPOTHESIS, by V. Braitenberg and N. Onesto. Jan. 1959, 17p. incl. diagrs. refs. (Technical note no. 2) (AFOSR-TN-59-471) (AF 61(052)96) AD 215230 Unclassified

Morphological evidence led to the assumption that the cerebellar cortex is a timing organ, i.e. a nerve net in which the precise timing of successions of impulses plays an important role. A study of the histology of the parallel fibers and the Purkinje cell system, translated into physiological and neurologic language supporting the importance of the cerebellar cortex in rapid voluntary movements, is presented. (ASTIA abstract)

1303

Naples U. Inst. for Theoretical Physics (Italy).

ON THE CONVERGENCE OF PERTURBATIVE EXPANSIONS, by A. Buccafurri and E. R. Caianiello. [1958] [4]p. (AFOSR-J30) (AF 61(052)434) Unclassified

Also published in Nuovo Cimento, v. 8: 170-173, Feb. 21, 1958.

It is shown that, when the space-time volume Ω of integration is taken finite and the free fermion and boson propagators $S^F(x,y)$ and $D^F(x,y)$ are bounded, in modulus, by finite quantities through some cut-off procedures, the perturbative expansions of the propagation kernels K_{NO}^P of electrodynamics and similar theories are convergent, with a finite radius of convergence. Further proof is offered in the particular case in which the limitation of $S^F(x,y)$ is obtained by allowing only a finite number of modes to the free fermion field. Such perturbative expansions have an infinite radius of convergence. The proof presented shows the mathematical reason of the holomorphy and is well suited for deeper investigations on the subject.

1304

Naples U. Inst. of Theoretical Physics (Italy).

A SYSTEM OF COUPLED OSCILLATORS AS A FUNCTIONAL MODEL OF NEURONAL ASSEMBLIES, by V. Braitenberg, E. R. Caianiello and others. [1959] [5]p. (AF 61(052)434) Unclassified

Published in Nuovo Cimento, Series X, v. 11: 278-282, Jan. 16, 1959.

A theoretical approach for constructing an electronic or mechanical model which would share with the living nervous system the properties of economy, capacity to recognize similarity, and the character of wholeness is discussed. Attempt is made to provide the most simple example of the process of signal transfer between input and output. It is found that since the coupling constants could be varied within wide ranges of values, that practically any number of different frequency spectra representing the output could be obtained to correspond to a very large number of input patterns. There exists good reason to believe that the model

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would be able to recognize similarities between figures, and that a model with memory could be obtained if the coupling constants between any two oscillators were taken as functions of all the past states of those two oscillators. The action of any oscillating unit on the oscillation of the whole array is dependent on the coupling and on the states of all other units.

1305

National Bureau of Standards, Washington, D. C.

MEASUREMENTS OF THERMAL DIFFUSIVITY IN SEMICONDUCTORS: InSb AND Mg_2Sn (Abstract), by I.

I. Sochard and J. H. Becker. [1959] [1]p. [CSO-680-56-39] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 134, Mar. 30, 1959.

Accurate measurements of thermal diffusivity k in metals have been made from analysis of temperature waves due to periodically heating one end of an effectively semi-infinite rod. Generally low-frequency heat pulses ($f \sim 1/100$ cps) and large samples (~ 25 cm long) are employed. In contrast, with smaller semiconductor samples ($\sim 0.5 \times 1 \times 10$ mm) we use higher frequency heat pulses ($f \sim 10$ -1000 cps) obtained by chopping light which is strongly absorbed at a large area surface of the specimen; temperature waves are deduced from thermoelectric power, Nernst, or bolometric steady-state voltages produced by the sample. Sandblasting reduces undesired photosignals. To calculate k from the bolometric and Nernst effects the ambipolar diffusion constant is required, with thermoelectric power voltages V , k is obtained from the slope of $\log V(f)^{1/2}$ vs $(f)^{1/2}$. Results on intrinsic samples at 300 and 400°K agree with calculations from known thermal constants, however, for InSb an anomalous nonlinearity appears when measuring the magnetic field dependence of the Nernst effect.

1306

National Bureau of Standards, Washington, D. C.

ATTENUATION COEFFICIENTS OF HIGH ENERGY X-RAYS, by H. W. Koch and J. M. Wyckoff. Final rept. May 1, 1959, 1v. incl. diagrs. tables, refs. (NBS rept. no. 6313) (AFOSR-TR-59-25) (CSO-680-57-2) AD 211761 Unclassified

Direct measurements were made of the total attenuation coefficients for x-rays in the energy range from 5 to 180 mev. The research has resulted in detailed attenuation coefficients in hydrogen, carbon, water and

aluminum, which demonstrate specific areas requiring further theoretical and experimental investigations. (Contractor's abstract)

1307

National Bureau of Standards, Washington, D. C.

BREMSSTRAHLUNG CROSS SECTION FORMULAS AND RELATED DATA, by H. W. Koch and J. W. Motz [1959] [113]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-25; AD 211761) (Sponsored jointly by Air Force Office of Scientific Research and Atomic Energy Commission under [CSO-680-57-2])

Unclassified

Also published in Rev. Modern Phys. v. 31: 920-955, Oct. 1959.

Theoretical formulas and related data are given in a form convenient for practical calculations. For some cases comparisons are made with experimental results and the accuracy of the formulas estimated.

1308

National Bureau of Standards, Washington, D. C.

X-RAY ATTENUATION COEFFICIENTS FROM 15 TO 80 MEV FOR HYDROGEN, CARBON, WATER, AND ALUMINUM, by J. M. Wyckoff and H. W. Koch. [1959] [41]p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-25; AD 211761) [CSO-680-57-2]

Unclassified

Also published in Phys. Rev., v. 117: 1261-1274, Mar. 1, 1960.

The x-ray attenuation coefficients for hydrogen, carbon, water, and aluminum have been measured in the energy range from 15 to 80 mev. Varying lengths of the attenuators were placed in a 90 mev bremsstrahlung beam in a good geometry experiment using a large sodium iodide total-absorption spectrometer as the detector. In the hydrogen case, a difference method employing cyclohexane (C_6H_{12}) and graphite was used.

The theoretical attenuation coefficients, due to electronic processes, were calculated using selected Compton and triplet cross sections in addition to the small quasi-deuteron cross sections. A pair cross section increase of 2.25% was required for carbon, water and aluminum to bring the total calculated coefficients into agreement with the measured coefficients in the 60 mev region. The difference between these calculated cross sections and the measured cross sections in the 15 to 50 mev region has been ascribed to the giant resonance nuclear absorption. A larger high energy tail to this absorption than predicted by (γ, p) and (γ, n) experiments is indicated. (Contractor's abstract)

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National Bureau of Standards, Washington, D. C.

THE RELATION BETWEEN THE ABSORPTION SPECTRA AND THE CHEMICAL CONSTITUTION OF DYES, by J. H. Gould and M. N. Inscoe. Final rept. Feb. 16, 1959 [19p. incl. diagrs. (NBS rept. no. 6307) (AFOSR-TR-59-15) (CSO-680-57-3) AD 210474

Unclassified

The principle areas of investigation were the association and the phototropism of dyes. Spectral changes produced in solutions of azo dyes as a result of association were observed; the changes appeared to be closely related to the forces involved in the binding of dyes to fibers. The spectra of aqueous solutions of certain trisazo dyes were observed to change with time in the presence of inorganic salts, with the appearance of a complex new band at wavelengths longer than those of the normal absorption bands. The rate of change and the maximum intensity observed for the new band were influenced by the temperature, age of the stock dye solutions, and the salt concentration. An apparently related phenomenon was observed in the spectra of acidified solutions of certain aminoazo compounds. In aqueous solutions of Congo Red, the indicator change in spectrum was followed by another slower change characterized by a new complex band at longer wavelengths. For phototropism studies, methoxyazo compounds were prepared by methylation of hydroxyazo dyes. The methoxyazo compounds exhibited changes in spectra on illumination depending upon the wavelength of the light used for illumination. The phototropism of indigo and thioindigo dyes was examined on cellulose or cellulose derivatives; there was no evidence of phototropism.

1310

National Bureau of Standards, Washington, D. C.

ON STOKES FLOW ABOUT A TORUS, by W. H. Pell and L. E. Payne. Sept. 22, 1959 [23p. incl. diagrs. refs. (NBS rept. no. 6546) (AFOSR-TR-59-151) (CSO-680-57-16) AD 228853

Unclassified

A collection of m bodies ($m \geq 1$) is considered each of which has an axis of symmetry, and arranged collectively in such a way that the aggregate also has an axis of symmetry. Let this configuration be immersed in a uniform flow of a viscous fluid, the axis of symmetry of the configuration of bodies taken parallel to the direction of the uniform flow. Assuming that U , the speed of the uniform flow, is so small that inertial effects of the motion are negligible in comparison with those of viscosity, a Stokes flow is obtained.

1311

National Bureau of Standards, Washington, D. C.

PHOTOCONDUCTIVE, PHOTOELECTROMAGNETIC,

BOLOMETRIC AND NERNST EFFECTS IN MAGNESIUM STANNIDE, by J. H. Becker and I. I. Sochard.

June 1, 1959, 77p. incl. diagrs. tables, refs. (NBS rept. no. 6437) (AFOSR-TN-59-591) (CSO-680-58-15) AD 217010

Unclassified

The photoeffects (photoconductivity and photoelectromagnetic effects) as well as the analogous thermal effects (bolometric and Nernst effects) have been studied in the semiconductor Mg_2Sn . Experimental investigations were made with monochromatic and filtered light interrupted at audio frequencies. Included are the dependence upon the temperature of the sample, the energy of the incident photons, and the frequency at which the light is interrupted for samples with various impurity contents and surface treatments. Theory and experiment are in reasonable agreement. Particular attention is devoted to the relative amounts of the photo and thermal effects which are measured in a given experiment; conditions which enhance the photo or thermal effects are verified. A new method to determine the thermal diffusivity from the ratio of the ac bolometric and Nernst effects is demonstrated. It is pointed out that experimental and theoretical difficulties associated with this method can be circumvented by measurement of both the dc and ac bolometric or Nernst effects. Optical absorption coefficients, surface recombination velocities, and electron-hole pair lifetimes are evaluated from the spectral dependence of the photoeffects. Absorption due to indirect transitions can account for the observed dependence of the absorption coefficient upon photon energy at 146°K. Lifetimes at 200°K ranged from 0.2 to .03 usec. The temperature dependence of the lifetimes between 140 and 250°K can be interpreted in terms of a simple Shockley-Read-Hall model. Below 140°K more complicated behavior is indicated. (Contractor's abstract)

1312

National Bureau of Standards, Washington, D. C.

SUPERCONDUCTIVITY, by C. A. Shiffman. Oct. 30, 1959 [73p. incl. diagrs. refs. (NBS rept. no. 6592) (AFOSR-TR-59-182) (CSO-680-59-3) AD 228853

Unclassified

The distribution of normal and superconducting domains in long circular cylinders of tin has been studied by measuring the variation of the magnetic field along the surfaces of suitably prepared specimens in a transverse external field. The magnetic field sensor was a minute bismuth resistor whose manufacture and properties are described. Details of the scanning apparatus, cryogenic equipment and electrical measuring system are also given. The domain distributions have been measured as a function of the external field, the temperature and the metallurgical state of the specimens. It is found that at a given temperature and field the domains are distributed periodically along the length of the specimen, with periodicities of the order of a few tenths of a millimeter. The relation between the periodicity and the surface energy at the normal-superconducting interfaces is discussed. It is shown that massive plastic deformation tends to increase the periodicity. Prolonged annealing

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reduces the periodicity up to a point, beyond which the principal result of further heat treatment is to reduce the fluctuations about the mean value. Histograms are presented to demonstrate this effect. In the case of most carefully treated samples the periodicity is shown to be proportional to the Gorter-Casimir value for the penetration depth over a wide range of temperatures. The field dependence, on the other hand, is shown to be in only rough agreement with the predictions of Landau's non-branching model. In addition the branching of domains to form sub-domains is demonstrated to occur under certain conditions. Preliminary results are presented to show that the domains may be either laminar or tubular, depending on the circumstances. The results are discussed in terms of the current theories of the intermediate state and of the surface energy. (Contractor's abstract)

1313

National Bureau of Standards, Washington, D. C.

A NEW METHOD OF SOLUTION FOR UNRETARDED SATELLITE ORBITS, by J. P. Vinti. July 1, 1959. 23p incl. diagr. tables, refs. (NBS rept. no. 6449) (AFOSR-TN-59-608) [CSO-680-59-4] AD 217395
Unclassified

An axially symmetric solution of Laplace's equation in oblate spheroidal coordinates is found, which may be used as the gravitational potential about an oblate planet. This potential, which makes the Hamilton-Jacobi equation for a satellite orbit separable, has an expansion in zonal harmonics in which the amplitudes of the zeroth and 2nd harmonics can be adjusted to agree exactly with the values for any axially symmetric planet and a 4th harmonic which then agrees approximately with the latest value for that of the earth. The net result is therefore a reduction of the problem of satellite motion to quadratures, with use of a potential field that is much closer to the empirically accepted one for the earth than any heretofore used as the starting point of a calculation. It may thus be possible to do the gravitational theory of a satellite orbit very accurately without use of perturbation theory. The method can take into account a first harmonic in the potential, in case observations are reduced to a center which does not coincide with the center of mass of the planet. (Contractor's abstract)

1314

National Bureau of Standards, Washington, D. C.

NEW APPROACH IN THE THEORY OF SATELLITE ORBITS, by J. P. Vinti. [1959] [1]p. [CSO-680-59-4]
Unclassified

Published in Phys. Rev. Ltrs., v. 3: 8, July 1, 1959.

If O is a center for the earth and if Oz points along the polar axis and Ox towards the vernal equinox, the oblate

spheroidal coordinates ξ, η, ϕ , defined by

$$x = c[\xi^2 + 1)(1 - \eta^2)]^{\frac{1}{2}} \cos \phi, (0 < \xi < \infty)$$

$$y = c[\xi^2 + 1)(1 - \eta^2)]^{\frac{1}{2}} \sin \phi, (-1 < \eta < 1)$$

$$z = c\xi\eta,$$

turn out to be a useful system of coordinates for investigating the motion of an earth satellite. In this coordinate system any axially symmetric potential $V(\xi, \eta)$ that results in separability of the Hamilton-Jacobi equation must have the general form

$$V(\xi, \eta) = (\xi^2 + \eta^2)^{-1} [f(\xi) + g(\eta)].$$

The net result of the present work is a reduction of the problem of satellite motion to quadratures, for a potential whose even harmonics are exact through the 2nd, and whose 4th harmonic is comparable with empirical values.

1315

National Research Council. National Academy of Sciences, Washington, D. C.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SCIENTIFIC INFORMATION, Washington, D. C. (Nov. 16-21, 1958), Washington, National Academy of Sciences, 1959, 2v. incl. illus. diagrs. tables, refs. [CSO-680-58-18]
Unclassified

This conference was jointly sponsored by the American Documentation Institute, the National Science Foundation, and the National Academy of Sciences—National Research Council. Its purpose was to bring together on an international level, scientists and information specialists for discussion of current research progress and problems concerned primarily with the storage and retrieval of scientific information. Approximately 75 papers were presented, covering the following topics: (1) Literature and reference needs of scientists; (2) Function and effectiveness of abstracting and indexing services; (3) Effectiveness of monographs, compendia, and specialized centers; (4) Organization of information for storage and search — Existing systems; (5) Organization of information for storage and retrospective search — Design of new systems; (6) Theories of information storage and retrieval; and (7) Responsibilities of government, professional societies, universities, and industry for better information services and research.

1316

National Research Council. National Academy of Sciences, Washington, D. C.

PROCEEDINGS OF AN INTERNATIONAL CONFERENCE ON THE ATOMIC MECHANISMS OF FRACTURE, Swampscott, Mass., Apr. 12-16, 1959, ed. by

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B. L. Averbach, D. K. Felbeck and others. Cambridge, MIT Technology Press, 1959, 646p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-213) (Sponsored jointly by Air Force Office of Scientific Research under [CSO-680-59-2], National Science Foundation, Office of Naval Research and Ship Structure Committee)
Unclassified

At a meeting designed to bring together both experimentalists and theorists working in the field of fracture mechanisms on an atomic scale, papers were presented dealing with theories, fatigue, and comparison of fractures. In all, 28 papers were presented on the history, work, and expectations in this field of study

1317

New Hampshire U. Dept. of Chemistry, Durham.

EVIDENCE FOR THE A-SE2 MECHANISM IN THE ACID-CATALYSED AROMATIC PHOTO-DEBORONATION, by H. G. Kuivila and K. V. Nahabedian. [1959] [2]p. incl. diagrs. (AFOSR-TN-59-667) (AF 49(638)-312) AD 246904
Unclassified

Also published in Chem. and Indus. (London), No. 36: 1120-1121, Sept. 5, 1959.

The acid-catalysed hydrolysis of p-methoxybenzeneboronic acid was studied spectrophotometrically and found to obey 1st order kinetics. The catalysis by molecular formic acid is thought to be the reason that the rate constant remains essentially constant through a unit change in the acidity function but then increases with increasing acidity. Two facts are revealed by the data: (1) the rate in protium solvent is 3.7 times greater than in a deuterium solvent; (2) the rates in isotopically mixed solvents are not predicted by the Grass-Butler theory.

1318

New Hampshire U. [Dept. of Physics] Durham.

CONDUCTIVITY OF A WARM PLASMA, by L. Mower. [1959] [3]p. (AFOSR-4289) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)-687] and Atomic Energy Commission) Unclassified

Also published in Phys. Rev., v. 116: 16-18, Oct. 1, 1959.

A theory for obtaining the conductivity of a uniform plasma as a function of frequency and temperature is presented and compared with a number of recent treatments. This research was stimulated by the different forms of the conductivity tensor reported by different investigators. It is shown that the parallel and transverse components of the electric field are mutually independent. The form of the components when propagation is parallel to or transverse to the direction of the dc field is also shown. However, in the case of propa-

gation of a plasma in a direction at an arbitrary angle to the dc magnetic field, even in the absence of thermal effects, the electric field of the independent modes possesses components both along and transverse to the direction of the dc magnetic field. For the general case of propagation at an angle to the direction of the dc magnetic field the elimination process is not valid.

1319

New Mexico U., Albuquerque.

FIRST INTERDISCIPLINARY CONFERENCE ON DECISIONS, VALUES AND GROUPS, New Mexico U., Albuquerque. (June 17-Aug. 10, 1959), ed. by D. Willner. New York, Pergamon Press, 1960, 348p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-66) (AF 49(638)-33)
Unclassified

This conference sought to bring together young men with a potential for growth to discuss subjects related to the behavior sciences. Its participants included experts in philosophy, mathematics, economics, anthropology, sociology, and psychology. The broad title of Decisions, Values, and Groups was chosen to encompass the whole spectrum of research in which these investigators would have an interest. The program was divided into 5 parts, the 1st 3 of which were the various divisions suggested by the title, plus a section dealing with psychodynamic patterns of behavior and 1 concerned with special military problems.

1320

New Mexico U., Albuquerque.

RELATIONSHIPS AMONG THE TRAITS OF THE PERCEIVER AND THOSE OF THE PERCEIVED IN IMPRESSION FORMATION, by D. T. Benedetti, R. M. Morgan, and D. W. Bessemer. Final rept. 5 pt. 1959 [48]p. tables, refs. (AFOSR-TR-59-187) (AF 49(638)33) AD 228829; PB 144787
Unclassified

Two questions were experimentally investigated: To what extent are the impressions one forms of other persons contingent upon the extent to which one possesses the traits one perceives in the others? When one perceives another person, is the resulting impression an integrated or a piece-meal cognition? College students were given controlled information about a series of hypothetical persons. The impressions they formed were measured in a variety of ways. The correlations among certain personality trait scores of the subjects and the measures of their impressions were determined. The major conclusions were: (1) in general, one's personality traits are not potent, overall determiners of the impressions one forms of others, although there are certain selective relationships here; and (2) impressions formed of other people clearly tend to be integrated cognitions, in the sense that judgmental responses based upon them are typically intercorrelated. This study is predicated upon the assumption that since interpersonal

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behavior is in part a function of personality impressions, the prediction and control of such behavior in military or other practical situations calls for grounding in knowledge gained by basic research.

1321

New Mexico U., Albuquerque.

INITIAL EXPECTATION, GROUP CLIMATE, AND THE ASSESSMENTS OF LEADERS AND MEMBERS, by E. F. Borgatta, L. S. Cottrell, Jr., and L. Wilker. [1959] [12]p. incl. tables. (In cooperation with New York U., N. Y.) (AF 49(638)33) Unclassified

Published in Jour. Social Psychol., v. 49: 285-296, May 1959.

The problems of generalizing from small group laboratory research are discussed. The type of questions that must be answered are does the group climate influence individual attitudes, or what is the relationship of the group climate to the individual or what is this relationship in "natural" social situations. The findings suggest that there is a stability of individual scores from the time of expression of expectation to the time of expression of assessment of experience. There appears to be a tendency for initial level of the group to influence the assessment of the individual in the direction of the group mean. Analysis of the data suggest also, however, that shifts toward the mean may occur faster (or more frequently) for leaders than for members, although this appears to be visible only in the data derived from the question on ability to understand other people. There also appears to be some tendency for leaders to have greater change than members in their assessments in the low groups than in the high groups.

1322

New Mexico U., Albuquerque.

REDUNDANCY IN TASK ASSIGNMENTS AND GROUP PERFORMANCE, by R. B. Zajonc and W. H. Smoke. [1959] [9]p. incl. diagrs. refs. (In cooperation with Michigan U., Ann Arbor) (AF 49(638)33) Unclassified

Published in Jour. Psychometrika, v. 24: 361-369, Dec. 1959.

The problem of combining abilities of group members to maximize the performance of the group as a whole is examined in terms of redundancy in task assignments. In particular, ways of distributing a given number of items of information among a given number of individuals to obtain the maximum probability of each item being recalled by at least one individual are studied. It is shown that there exists an optimal distribution scheme which is independent of the amount of material originally given, the size of the group, and individual differences in ability.

1323

New Mexico U. Dept. of Physics, Albuquerque.

ON THE RESPONSE OF A SINGLE LARGE SCINTILLATOR TO EXTENSIVE AIR SHOWERS, by J. R. Green. May 4, 1959 [25]p. incl. diagrs. tables, refs. (AFOSR-TN-59-490) (AF 49(638)34) AD 215843; PB 142021 Unclassified

Also published in Nuovo Cimento. Series X, v. 14: 1342-1355, Dec. 16, 1959. (Title varies)

The known properties of extensive cosmic ray air showers are applied to predict the response of single scintillator. Questions of particular interest are the relation of the number-spectrum of the particles traversing a single scintillator to the number spectrum of the extensive air showers, and the average size of the showers that result in a given number of particles traversing the scintillator. In cases where particular values are indicated, they are computed for the elevation of Albuquerque, N. M., namely, 1575 m s l, and for a scintillator whose diam is 10 ft and whose area is 7.3 m^2 . (Contractor's abstract)

1324

New Mexico U. Dept. of Physics, Albuquerque.

SIZE-SPECTRUM OF EXTENSIVE AIR SHOWERS OF THE COSMIC RADIATION, by J. R. Green and J. R. Barcus. Oct. 7, 1959 [14]p. incl. diagrs. (AFOSR-TN-59-1068) (AF 49(638)34) AD 227953; PB 144342 Unclassified

Also published in Nuovo Cimento, Series X, v. 14: 1356-1365, Dec. 16, 1959. (Title varies)

The operation and calibration of a single scintillator of area 7.3 sq m are discussed. There are 2 basic calibrations. The 1st is the so-called single particle (the size of the pulse produced by a single, minimum-ionizing particle passing through the scintillator) and is obtained at a relatively high voltage for the photomultiplier. It leads to a 2nd calibration, i.e., the change in the photomultiplier amplification from that in high potential to the lower potential at which the photomultiplier is actually operated to detect events producing 10^2 to several times 10^3 particles in the scintillator. The photomultiplier is found to saturate for large pulses so that the range investigated is limited by this effect at the high end. The results of different analyzing circuits are combined to give the integral spectrum of pulses in the scintillator for a wide particle range. From about 30 particles to the upper limit of the apparatus, the spectrum is very regular and has a constant logarithmic slope of -1.51. From 10^5 to 10^8 particle range, it is deduced to have also a regular integral spectrum. As to spectrum of below 30 particles, there

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is marked change of slope as a result of a different phenomenon, i.e., the local production of small nuclear events in the liquid of the scintillator.

New York State Coll. of Ceramics, N. Y. see
Alfred U. New York State Coll. of Ceramics, N. Y.

1325

New York U., N. Y.

CONFERENCE ON THE PHYSICS OF ELECTRONIC AND ATOMIC COLLISIONS, PROGRAM AND ABSTRACTS OF PAPERS, New York U., N. Y. (Jan. 27-28, 1958) [1958] 78p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and New York U.)

Unclassified

This conference brought together researchers investigating the phenomena and properties of electronic and atomic collisions. The papers are concerned with elastic and inelastic electron-atom scattering, atom-atom and atom-ion collisions, photon-atom collisions, and charge exchange.

1326

New York U., N. Y.

THE SCATTERING OF ELECTRONS BY FREE ELECTRONS, by A. Shadowitz, P. Nektaredes, and M. H. Shamos. Final rept. Jan. 1, 1958 [80]p. incl. diagrs. tables, refs. (AFOSR-TR-59-72) (AF 18(600)911) AD 218069; PB 142301

Unclassified

The scattering of electrons by free electrons was investigated experimentally by means of 2 intersecting electron beams. With a 30° angle between the beams the collisions produce higher and lower energy components in the forward cone. The higher energy component was detected with an electron multiplier preceded by a velocity gate; the latter rejected background scattering as well as the lower energy component. The scattered intensity was measured between 55° and 125° in the center-of-mass system. The energy in that system was 550 ev. The results, with statistics of about 3%, do not correspond either with the Rutherford or with the Mott scattering theories. Instead, the points lie on a curve which corresponds to a symmetric space wave function. The author's are unable to account for this unexpected result.

1327

New York U., N. Y.

SPONTANEOUS IGNITION PROPERTIES OF METAL ALKYLs, by J. Marsel and L. Kramer. [1959] [7]p. incl. illus. diagrs. tables. (AF 49(636)173) Unclassified

Published in Seventh Symposium (Internat'l.) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958), London, Butterworths Scientific Publications, 1959, p. 906-912.

Delays are reported for spontaneous ignition in air of Et_3Al , Me_3Al , a $\text{Et}_3\text{Al}-\text{Me}_3\text{Al}$ mixture (1:3), and a $\text{Me}_3\text{Al}-\text{JP-5}$ mixture (9:1). The ease of spontaneous ignition of these materials suggests their use as igniters for jet engines at high altitudes.

1328

New York U. Coll. of Engineering, N. Y.

EFFECT OF GASEOUS IMPURITIES IN BF_3 PROPORTIONAL COUNTERS, by J. Davila-Aponte. Dec. 1958 [49]p. incl. diagrs. tables, refs. (AFOSR-TN-59-162) (AF 18(600)1555) AD 211141; PB 140619

Unclassified

The effects which SiF_4 , SO_2 , SF_6 have on the plateau and pulse size distribution of a proportional counter were investigated. SiF_4 was tested at 3 pressures; 30, 45, and 60 cm of BF_3 and its effect was found to be independent of the counter pressure for the range of values considered. From the variation in the plateau, the attachment probability for SiF_4 was calculated to be $h = 1.458 \times 10^{-5}$ and its cross section for attachment to be $\sigma_a = 5.12 \times 10^{-20} \text{ cm}^2$. The permissible amounts of these gases without the counter being affected beyond the limits of tolerance which are set up were found to be 0.04% for SiF_4 , 0.01% for SO_2 , and $2.0 \times 10^{-6}\%$ for SF_6 . (Contractor's abstract)

1329

New York U. Coll. of Engineering, N. Y.

A STUDY OF DEAD TIME AND RESOLVING TIME IN A PROPORTIONAL COUNTER, by W. Reidy. Jan. 1959, 38p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-501) (AF 18(600)1555) AD 229385; PB 144492

Unclassified

Measurements were made on a helium isobutane counter, which determined the variation of dead time and resolving time with voltage and pulse amplitude. The purpose was to determine the dead time and resolving time of the counter when operated in the proportional region and contrast this with operation in the geiger region. Results were obtained from photographs and direct measurements of the counter pulse as displayed on an oscilloscope. The dead time in the proportional region was observed as less than $1 \mu\text{sec}$, while in the geiger region, it is of the order of several hundred μsec . In

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addition, measurements were made by the two-source method to determine the resolving time of a proportional counter and its associated electronic counting system. These measurements gave results of the order of 5 μ sec.

1330

New York U. [Coll. of Engineering] N. Y.

PLATEAU SLOPES AND PULSE CHARACTERISTICS OF LARGE, HIGH PRESSURE BF_3 COUNTERS, by R.

B. Mendell. July 1959, 1v. incl. diagrs. refs. (AFOSR-TN-59-738) (AF 18(600)1555) AD 230018; PB 144936
Unclassified

Also published in part in Rev. Scient. Instr., v. 30: 442-444, June 1959.

Factors affecting the flatness in a plateau of large diameter, high pressure BF_3 counters were examined.

It was found that with gas and counter body free from contamination, counters up to 5 cm radius and filled with BF_3 gas at 64 cm Hg, had acceptably flat plateaus.

Desired gas purity was obtained by generating the gas from $\text{C}_2\text{F}_2\text{BF}_3$ complex, trapping residual impurities, and isolating and collecting BF_3 vapor that was in equilibrium with the liquid phase at a vapor pressure of 20 cm Hg.

The resolution of counters of different pressures and cathode diameter for ionizing events with a known energy spectrum was compared. Pulse amplification characteristics of the different counters were determined, and results, including the effect of electron attachment on measured values for counters of large diameter and high pressure are discussed.

1331

New York U. [Coll. of Engineering] N. Y.

[RESEARCH IN THE FIELD OF RADIATION DETECTION EQUIPMENT, SPECIFICALLY COUNTERS], by S. A. Korff. Final rept. Nov. 1, 1959, 4p. (AFOSR-TR-59-176) (AF 18(600)1555) AD 230018; PB 144936
Unclassified

This project was set up to study the radius effect and the effects of impurities in BF_3 neutron counters.

The main difficulty to be overcome was to construct counters which are large size and still have good plateau characteristics. This problem is of great practical importance since the efficiency of a BF_3 counter for detecting neutrons depends on its size. Good counters with very flat plateaus were obtained by extending the purification of the gas. A study was also made of the impurities which arise owing to the normal method of preparing the counters and the filling gas. The impurities studied were sulfur dioxide, silicon tetrafluoride, and sulfur hexafluoride. A study

was also made of the dead times and resolving times of proportional and Geiger counters. In this study the electronic circuits necessary to determine these times are set up to trace the problem through the transition, from proportional counter operation to the Geiger region.

1332

New York U. [Coll. of Engineering] N. Y.

PROPORTIONAL AND GEIGER COUNTERS, by S. A. Korff. [1959] [20]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1555] and Office of Naval Research)
Unclassified

Published in Radiation Hygiene Handbook, New York, McGraw-Hill, 1959, p. 10-33-10-52.

A general discussion of proportional and geiger counters and their characteristics of operation are presented. The general makeup of proportional counters is discussed, and the effects of varying conditions under which they operate is analyzed such as increasing the voltage across the counter. Terms and definitions applicable to proportional counters are discussed also; and finally examples of typical problems and special uses of counters are discussed. Concerning geiger counters, the factors which differentiate them from proportional counters are shown. Effects of varying the voltage is also discussed in some detail. A list of terms and their definitions concerning geiger counters is followed by a detailed discussion of different-type geiger counters and their particular uses.

1333

New York U. Coll. of Engineering, N. Y.

ATTEMPTS AT DERIVATION OF TRANSITION FROM LAMINAR INTO TURBULENT FLOW ALONG A FLAT PLATE, by H. B. Keller, D. F. De Santo, and R. Parthasarathy. Progress rept. June 1959, 26p. incl. diagrs. (AFOSR-TN-59-686) (AF 18(603)25) AD 226270; PB 144324
Unclassified

Successful progress is reported on this research, in the following areas: (1) determination of initial-field and base-flow parameter values; (2) preparation of complete detailed instructions for programming the solution of the finite-difference equation for vorticity; (3) development of a numerical scheme for solving the linear equations associated with the solution of the vorticity equation; (4) carrying out a theoretical analysis of propagation of disturbances into the potential flow exterior to the boundary layer, so as to establish a permissible location for the upper horizontal boundary; (5) calculation of initial vorticity-propagation characteristics as given by the proposed finite-difference

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solution (in order to check the validity of the method as well as the correctness of subsequent machine computations; and (6) initiation of actual programming.

1334

New York U. Coll. of Engineering, N. Y.

EXPLORATORY RESEARCH ON THE THEORETICAL CONSIDERATION OF WASTE WATER CYCLES IN A CLOSED ECOLOGICAL SYSTEM, by W. T. Ingram, B. Newman and others. [1958] 16p. incl. tables. (AFOSR-TN-59-87) (AF 18(603)71) AD 210087; PB 142540
Unclassified

Presented at Symposium on the Closed Ecological System, AAAS meeting, Washington, D. C., Dec. 31, 1958.

The probable wastes in a closed ecological system were classified to include feces, urine, sebaceous gland excretions, perspiration, respiratory end products, washings containing soil from clothing, and washings containing food particles as a result of food preparation and service. Problems concerning waste water cycling were presented. It was found to be problematical that the high treatment efficiencies required to maintain water balance in the system could be achieved without the development of techniques peculiarly adapted to the conditions of space ecology. Urine studies were summarized to determine the feasibility of recovery of water from urine by distillation process followed by adsorption on different materials.

1335

New York U. Coll. of Engineering, N. Y.

EXPLORATORY STUDIES IN THREE DIMENSIONAL PHOTOTHERMOELASTICITY, by H. Trampusch and G. Gerard. Sept. 1959 [59]p. incl. illus. diagrs. refs. (Technical rept. no. SM-59-5) (AFOSR-TN-59-1069) (AF 49(638)337) AD 229377
Unclassified

The exploratory application of the photo-thermoelastic method is made to 3-dimensional thermal stress problems. Several of the existing 3-dimensional photoelastic techniques seemed applicable, but were found undesirable. Rather, a completely new technique was developed which utilizes an embedded polariscope consisting of 2 sheets of polarizing material cemented within the models. The technique has proved to be simple to apply particularly to axisymmetric bodies and the resulting fringe patterns are readily interpreted. The systematic evaluation of the new technique starts with strength tests of cemented joints. Then a simple bending model and a sphere are tested under mechanical loading and the resulting fringe patterns are compared with results obtained by other methods. The new technique is applied to thermal stress problems with simple 3-dimensional geometries for which theoretical solutions are available. The investigations indicate the

general applicability of the new sandwich technique to 3-dimensional stress problems generated by mechanical or thermal loads. The technique is particularly applicable to thermal stress problems where other experimental stress analysis methods are not highly developed. (Contractor's abstract)

1336

New York U. Dept. of Chemistry, N. Y.

DEVIATION FROM THE KINETIC STEADY-STATE APPROXIMATION IN A FREE-RADICAL FLAME, by E. S. Campbell, J. O. Hirschfelder, and L. M. Schallit. [1959] [7]p. incl. diagrs. tables, refs. (In cooperation with Wisconsin U., Madison) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-(638)169 and Bureau of Ordnance under NOrd-15884)
Unclassified

Published in Seventh Symposium (Internat'l.) on Combustion, Oxford U., London (Gt. Brit.) (Aug. 28-Sept. 3, 1958). London, Butterworths Scientific Publications, 1959, p. 332-338.

The flame equations are solved for a model free-radical flame in which a fuel A burns to a product C by means of an intermediate reaction of A and a free-radical B. It is shown how deviations from the steady-state approximation affect the distribution of A, B, and C in the flame. The objective of the study is to test mathematical methods applicable to more complex flames.

1337

New York U. Dept. of Electrical Engineering, N. Y.

OPTIMIZATION OF THE ADAPTIVE FUNCTION BY Z-TRANSFORM METHOD, by S. S. L. Chang. Nov. 1959 [35]p. incl. diagrs. tables, refs. (Technical rept. no. 400-6) (AFOSR-TN-59-585) (AF 49(638)586) AD 217032; PB 144276
Unclassified

Also published in Trans. Amer. Inst. Elec. Engineers, v. 79(Pt. II): 223-231, July 1960.

A study is made on the optimization of the adjustment process in a self-optimizing system under rather general assumptions. The system is designed to keep a performance parameter m either at a prescribed value or at an unknown extremal value. A direct measurement on m is made, and the adjustment is based on measured m only. Factors considered are (1) the finite measuring interval, (2) the necessity of looking ahead one interval, (3) the probable error in measurement, and (4) the changing situation. A set of weighting factors on present and past data, and the proper value of test bias for extremal seeking systems, are determined by a least square optimization process. The criterion of optimization is least reduction in m for peak seeking systems and least square error in m for systems with prescribed value of m . Two types of extremal seeking

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systems are studied. The alternate biasing systems are found to be superior in performance compared to the derivative sensing systems. (Contractor's abstract)

1338

New York U. Dept. of Electrical Engineering, N. Y.

TRANSIENT RESPONSE AS A DESIGN CRITERION FOR STABILIZATION OF FEEDBACK AMPLIFIERS, by J. H. Mulligan, Jr. Sept. 1959 [26]p. incl. diagrs. tables. (Technical rept. no. 400-5) (AFOSR-TN-59-1075) (AF 49(638)586) AD 229481; PB 144770

Unclassified

Presented at Nat'l. Electronics Conf., Chicago, Ill., Oct. 12-14, 1959.

Also published in Proc. Nat'l Electronics Conf., v. 15: 1-14, 1959.

A design criterion for use in the stabilization of feedback amplifiers is discussed which is concerned directly with pole locations and with a feature of the transient response. The criterion is the relative damping of the amplifier step-function response, i.e., the ratio of the deviations from unity in the normalized time response at 2 successive extreme values. Use of the proposed criterion in conjunction with a dominant term approximation to the transient response to formulate design equations for representative transistor and vacuum tube amplifier stages is demonstrated. Transient response curves for a particular design using various values of mid-band loop gain illustrate the effect of parameter changes on the stabilization design parameter. (Contractor's abstract)

1339

New York U. Dept. of Electrical Engineering, N. Y.

ON THE WIENER PREDICTION PROBLEM AND THE PROBLEM OF THE OPTIMIZED NOISE FREE AUTOMATIC CONTROLLER, by N. Aslund. Oct. 1959, 16p. (Technical note no. 400-2) (AFOSR-TN-59-1100) (AF 49(638)586) AD 229483; PB 144783

Unclassified

A solution is presented of the Wiener prediction problem in the sampled, non-stationary case. The derivation is simpler and more direct. The problem of minimizing a generalized loss-function defined for a sampled, noise-free automatic controller is solved by using a geometrical projection technique. The concept of orthogonal projection is fundamental for the solution of both problems and is shown to account for the structural resemblance of the final results. The principal difference between the 2 is also emphasized by the methods used.

1340

New York U. Dept. of Electrical Engineering, N. Y.

INFORMATION FLOW CRITERIA FOR FEEDBACK CONTROL SYSTEMS, by S. S. L. Chang. Jan. 1960 [29]p. incl. diagrs. (Technical rept. no. 400-8) (AFOSR-TN-59-1328) (AF 49(638)586) AD 231893; PB 146715

Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 2: 712-716, 1960.

Information capacity in Shannon's sense is suggested as an additional criterion for control systems and components. This criterion applies equally well to linear as well as nonlinear systems, and enables a designer to determine the tolerable amounts of small signal nonlinearities in components. Equations are derived for calculating required system capacity from given signal properties and allowed error, loss of information rate in system components, required capacities of system components, and calculation of information capacities from the characteristics of system components with either direct or indirect limiting. (Contractor's abstract)

1341

New York U. Dept. of Sociology, N. Y.

THE STABILITY OF INTERPERSONAL JUDGMENTS IN INDEPENDENT SITUATIONS, by E. F. Borgatta. [1959] [16]p. incl. table, refs. (AFOSR-TN-59-42) (AF 49(638)195) AD 209214; AD 238861

Unclassified

Also published in Jour. Abnorm. Social Psychol., v. 60: 188-194, Mar. 1960.

The following aspects that have generally received attention separately are discussed together: (1) the limited number of contents that will account for most of the variance of interpersonal ratings; (2) data from studies on the consistency of interpersonal rankings in independent situations; and (3) the interrelationship of self-ratings, self-rankings and peer rankings. Analysis of 99 male subjects revealed that self-ratings may be predictors of the self-rankings that are made after 5- and 3-person discussion situations, independent of content. Examining the magnitude of predictions, it appears that correlations to peer rankings are larger for the 5- than for the 3-person self-rankings. Three types of content that tend to be orthogonal were utilized in the ratings and rankings and were demonstrated to operate in parallel for the relationships examined.

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New York U. [Dept. of Sociology] N. Y.

PERSONALITY AND BEHAVIOR CORRELATIONS OF CHANGES PRODUCED BY ROLE PLAYING EXPERIENCE, by J. H. Mann and E. F. Borgatta. [1959] [22]p. incl. tables. (AFOSR-TN-59-500) (AF 49(638)-195) AD 215925
Unclassified

Also published in Psychol. Repts., v. 5: 505-526, Sept. 3, 1959.

The possibility of inducing change in personality and behavior characteristics through short-term role playing techniques is examined. The relationship that exist between criterion variables, the relative prognostic efficiencies of these variables and the dependencies that exist between these variables when they are utilized as measures of change are discussed. In general, the findings on the change variables involve some variation beyond that expected on a change basis, but the amount and magnitude of relationships found require caution in interpretation.

1343

New York U. [Dept. of Sociology] N. Y.

THE GENERAL ORIENTATIONS PROFILE (GOP), by E. Francesco. [1959] [9]p. incl. tables. (AFOSR-TN-59-619) (AF 49(638)195) AD 264386
Unclassified

Also published in Psychol. Repts., v. 5: 561-569, Sept. 3, 1959.

A presentation is made of the development of a new brief inventory, factorially based, designed to tap in an economical manner 7 dimensions of orientation and 5 interest clusters. The selection of dimensions and clusters emphasized replication of the structure of relationships among items and also among clusters in 183 male and 84 female college sophomores and juniors. Examination of the GOP scores in their relation to Gullford-Zimmerman (GZ) scores indicates that the GOP taps some of the same content as the GZ. In part, since the GOP scores tend to be defined in more specific terms, some interpretation of the GOP scores through the GZ scores is possible. The relationships found between the 2 tests are easily interpretable in some cases, and in others may prove to be revealing of particular connotations of the subscales involved. Subsequent reports will present analyses of the GOP with other personality inventories and with more direct measures of behavior. (Contractor's abstract)

1344

New York U. [Dept. of Sociology] N. Y.

POWER STRUCTURE AND COALITIONS IN THREE

PERSON GROUPS, by M. L. Borgatta. [1959] [28]p. incl. diagrs. refs. (AFOSR-TN-59-679) (AF 49-(633)195)
Unclassified

Also published in Jour. Social Psychol., v. 5: 287-300, Dec. 1961.

An investigation of 3-man groups is presented. The study indicates that there are several ways in which the members of 3-man groups may influence each other in reaching a decision or taking action on a group task and in developing a stable organization for control of the group. In one type of problem solving situation involving the 2 most active and aggressive persons, individuals will usually work toward agreement, and ignore or carry along the 3rd person. In other situations, such as that of a 3-man bomber crew, the influence of each member in working at a task problem is controlled by the assigned status structure of the team. The study concludes that the problem of the composition and functioning of 3-person task groups merits further consideration in view of the spotty and inconclusive results of past research in this area. (Contractor's abstract, modified)

1345

New York U. [Dept. of Sociology] N. Y.

THE GENERAL ORIENTATIONS PROFILE (GOP): VALIDATION STUDIES, by E. Francesco. (AFOSR-TN-59-809) (AF 49(638)195)
Unclassified

Also published in Psychol. Repts., v. 6: 255-265, Apr. 1960.

The GOP scores appear to be pervasively and intelligibly related to data which include personality inventory subtests, self-rankings, peer rankings, and a measure of intelligence. The magnitudes of the correlation coefficients and the unique definitions in the patterns of correlations of the GOP scores are in some cases impressive, particularly when considered in the light of the attenuation due to the unreliability of criterion measures and also of the logical and empirical restrictions that occur when panels of orthogonal measures are intercorrelated. While the GOP has all the shortcomings of inventories and checklists that permit the respondent to structure an image of himself, the findings indicate that the responses made are coherent and interpretable in terms of other measures. Since the GOP is a relatively brief form with a broad substantive coverage, this approach to assessing values and interests should be efficient in many contexts. (Contractor's abstract)

1346

New York U. Dept. of Sociology, N. Y.

STUDIES OF ROLE PERFORMANCE, by J. H. Mann. [1959] [44]p. incl. tables. (AFOSR-TN-59-1296) (AF 49-(638)195)
Unclassified

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Also published in Genetic Psychol. Monographs, v. 64: 213-256, Nov. 1961.

The studies described in this monograph are concerned with establishing the relations between stable and efficient measures of role performance. Specifically these studies examine self-report descriptions of 5 role performances in order to determine the dimensions in terms of which each of these role performances ought to be measured; whether the same dimensions can be used to measure different role performances; whether persons act consistently in different role performances; and whether it is meaningful to attempt to derive a role performance typology.

1347

New York U. Dept. of Sociology, N. Y.

SOME RELIGIOUS-ETHNIC DIFFERENCES IN INTERACTION RATES, by J. Stimson. [1959] [12]p. incl. tables. (AFOSR-TN-59-1297) (AF 49(638)195)

Unclassified

Also published in Psychol. Repts., v. 7: 345-356, Oct. 1960.

College sophomores and juniors (N = 133) were divided into groups composed of Jewish, Catholic, Protestant, and No Religious Preference. The Jewish group was further divided into 3 subgroups; those of Slavic, Industrial European, or other ethnic origins. The Slavic group was large enough to be again divided into those of 2nd and 3rd generation of US residence. Using these subsamples the influence of background characteristics on action initiated and interpersonal judgments in group discussion situations was examined. The total interaction by each S was recorded using Interaction Process Scoring, Borgatta's revision of Bales' Interaction Process Analysis. Mean scores for each subsample were developed on these 19 types of behavior and on rankings of Behavioral Characteristics. Significant differences were found between the subsamples in the actual amounts of different types of behavior initiated and in the mean rankings by self and peers in the Behavioral Characteristic areas. (Contractor's abstract)

1348

New York U. [Dept. of Sociology] N. Y.

PERSONALITY CONCOMITANTS OF EXTREME RESPONSE SET (ERS), by E. F. Borgatta and D. C. Glass. [1959] [9]p. incl. tables, refs. (AFOSR-TN-59-1316) (AF 49(638)195)

Unclassified

Also published in Jour. Social Psychol., v. 55: 213-221, Dec. 1961.

Extreme response set and related concepts are considered in the framework of personality characteristics. ERS, defined on a panel of variables from a

test of values that is based on factor analytic study, is compared for 3-type of Ss. Correlation to the subsets of the Cattell Sixteen Personality Factor Questionnaire and the Edwards Personal Preference Schedule indicates that there is little relationship between ERS and the subsets. The lack of consistency raises serious questions about the psychological meaningfulness of ERS.

1349

New York U. [Inst. of Mathematical Sciences] N. Y.

NUMERICAL SOLUTION OF PROBLEMS WHICH ARE NOT WELL POSED IN THE SENSE OF HADAMARD, by F. John. [1959] [14]p. incl. refs. (AFOSR-TN-59-495) (AF 49(638)161)

Unclassified

Also published in Proc. Rome Symposium on Numerical Treatment of Partial Differential Equations with Real Characteristics, Rome (Italy) (Jan. 28-30, 1959). p. 103-116.

It is pointed out that most problems of physical interest are not well-posed in the sense of Hadamard, since the data are neither completely known nor perfectly accurate. The approximate solution of a large class of not-well-posed problems is formulated in a general setting. The error bound depends both upon the approximation scheme being used and upon the error in the data. The latter puts an inherent limitation on the accuracy of the approximation scheme. The problem is called well-behaved if the error due to an inaccuracy δ in the data is of the order of a positive power of δ . Examples are given of both well-behaved and not-well-behaved not-well-posed problems. It is pointed out that the error made in approximating the solution of a well-behaved not-well-posed problem by means of a fixed finite difference scheme with optionally chosen mesh h is of an order larger than any positive power of δ since such a scheme is unstable for small h . Thus in order to obtain an error of an order of δ one must let the finite difference scheme itself depend upon δ . (Math. Rev. abstract)

1349 a

New York U. [Inst. of Mathematical Sciences] N. Y.

SPHERICAL CAP SNAPPING, by H. B. Keller and E. L. Reiss. [1959] [10]p. incl. diagrs. refs. (AF 49-638)161)

Unclassified

Published in Jour. Aero/Space Sci., v. 26: 643-652, Oct. 1959.

A nonlinear boundary value problem for the determination of the rotationally symmetric deformations of a clamped spherical cap under external pressure is solved by finite differences. The numerical solutions are obtained by employing a previously developed iteration procedure. A special case of the difference equations is solved explicitly and yields a justification of the

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iteration method as well as insight into the properties of the more accurate numerical solutions. Buckled and unbuckled equilibrium states are obtained and the shape of the pressure-deflection curve which is usually assumed for these states is verified for a large class of caps. Close estimates are given for the upper and lower buckling loads and an intermediate buckling load, i.e., the "dead-weight" load. The stresses and deflections in the buckled and unbuckled states are examined and compared with an asymptotic solution valid in the interior of very thin shells. Boundary layers are found to develop in the buckled states both as the loading increases and as the thickness of the shell decreases.

1350

New York U. Inst. of Mathematical Sciences, N. Y.

THE DISCRIMINANT OF HILL'S EQUATION, by W. Magnus. May 1959, 40p. (Research rept. no. BR-28) (AFOSR-TN-59-576) (AF 49(638)229) AD 217023
Unclassified

Explicit expressions for the discriminant of Hill's equation up to terms of order 4 are being calculated. It is shown that these formulas permit a new proof of a theorem about the asymptotic distribution of the characteristic values. They also permit the derivation of certain summation formulas involving the lengths of the intervals of instability and the Fourier coefficients of the periodic function appearing in Hill's equation. (Contractor's abstract)

1351

New York U. Inst. of Mathematical Sciences, N. Y.

THE INFLUENCE OF EDGES AND CORNERS ON POTENTIAL FUNCTIONS OF SURFACE LAYERS, by R. Leis. June 1959, 21p. (Research rept. no. BR-29) (AFOSR-TN-59-943) (AF 49(638)229) AD 228551; PB 144766
Unclassified

Also published in Arch. Rational Mech. and Anal., v. 7: 212-223, 1961.

The potential functions of multiple surface layers behave singularly when approaching the boundary of the surface. The degree of the singularities of these functions and their derivatives are discussed. (Contractor's abstract)

1352

New York U. Inst. of Mathematical Sciences, N. Y.

ON SOME FREDHOLM INTEGRAL EQUATIONS ARISING IN DIFFRACTION THEORY, by C. H. Yang. Aug. 1959, 18p. incl. diagrs. (Research rept. no. BR-31) (AFOSR-TN-59-944) (AF 49(638)229) AD 229003; PB 144765
Unclassified

Kernels of integral equations arising in diffraction theory are investigated. These kernels depend on a parameter α . Fredholm's theory shows that the resolvents of the kernels are meromorphic functions of α and, hence, can be expanded into power series of α which are convergent for certain regions. Regions of convergence for α , in which the perturbation method would work, are examined. (Contractor's abstract)

1353

New York U. Inst. of Mathematical Sciences, N. Y.

ON THE DIRICHLET PROBLEM FOR THE REDUCED WAVE EQUATION, by R. Leis. June 1959, 23p. incl. refs. (Research rept. no. BR-30) (AFOSR-TN-59-945) (AF 49(638)229) AD 231668; PB 145743
Unclassified

An existence theorem for the exterior Dirichlet problem for the reduced wave equation is given for piecewise smooth surfaces.

1354

New York U. Inst. of Mathematical Sciences, N. Y.

A FORMAL SOLUTION OF THE EQUATIONS OF STATISTICAL EQUILIBRIUM, by B. Zumino. Oct. 1958, 7p. incl. refs. (Research rept. no. HT-1) (AFOSR-TN-59-74) (AF 49(638)341) AD 209849; PB 140038
Unclassified

Also published in Phys. Fluids. v. 2: 20-22, Jan.-Feb. 1959.

A closed expression is given for the distribution functions in the classical theory of statistical equilibrium. This expression, when suitably expanded, permits one to obtain the general term in the virial expansion of the distribution functions and of the equation of state. (Contractor's abstract)

1355

New York U. Inst. of Mathematical Sciences, N. Y.

MEASURE-THEORETIC FOUNDATIONS OF STATISTICAL MECHANICS, by R. M. Lewis. Apr. 1959, 46p. (Research rept. no. HT-2) (AFOSR-TN-59-307) (AF 49(638)341) AD 213091; PB 140588
Unclassified

The basic formulas of classical equilibrium statistical mechanics are derived from well-known theorems in measure theory and ergodic theory. The method used is a generalization of the methods of Khinchin and Grad and deals with a complete set of invariants or integrals of the motion. Most of the results are simple corollaries of Birkhoff's ergodic theorem, and since time-averages are used, the whole approach is characterized by an absence of statistical ensembles and probability notions. In the course of the development a generalized

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temperature is introduced, and a generalization of the second law of thermodynamics is derived. Formulas for the microcanonical, canonical, and grand canonical distributions appear as special cases of the general theory. (Contractor's abstract)

1356

New York U. Inst. of Mathematical Sciences, N. Y.

A SOLUTION OF THE EQUATIONS OF STATISTICAL MECHANICS, by R. M. Lewis. Nov. 1959, 21p. (Research rept. no. HT-3) (AFOSR-TN-59-1216) (AF 49-638)341 AD 230291 Unclassified

The solution of the initial value problem for Bogoliubov's functional differential equation of non-equilibrium statistical mechanics is obtained. This solution is then expanded in an infinite power series in the density which has the advantage that the calculation of the lead terms requires the solution of s-body problems only for small values of s. A derivation of the equilibrium equation by reduction from the non-equilibrium equation is included. (Contractor's abstract)

1357

New York U. Inst. of Mathematical Sciences, N. Y.

CLASSICAL FLUCTUATION - RELAXATION THEOREM, by R. H. Kraichnan. [1959] [2]p. (AF 49-638)341 Unclassified

Published in Phys. Rev., v. 113: 1181-1182, Mar. 1, 1959.

A general expression is derived for the average infinitesimal-impulse-response matrix of a conservative classical system in a canonical ensemble. The equations of motion are taken as $\dot{x}_n = X_n$, where the X 's,

as well as the energy E , are functions of the x 's but not of their time derivatives. The Liouville equation $\Sigma \partial x_n / \partial x_n = 0$ is assumed, but it is not required that the equations of motion be derivable for a Hamiltonian. If they are, the x 's are the canonical coordinates and momenta. The result found in $g_{mn}(\tau) = \phi_{mn}(\tau)/kT$, ($\tau > 0$), where $\phi_{mn}(\tau)$ is the average increment in x_m at t resulting from an infinitesimal increment ϵ externally induced in x_n at time $t-\tau$, $\phi_{mn}(\tau)$ is the covariance $\langle x_m(t) (\partial E / \partial x_n) \rangle'$, where the prime denotes argument $t-\tau$, k and T are Boltzmann's constant and absolute temperature. This relation is derived as a direct consequence of the fact that 2 initially isolated systems in equilibrium at identical temperatures remain in equilibrium when weakly coupled to each other. (Contractor's abstract)

1358

New York U. Inst. of Mathematical Sciences, N. Y.

CONDENSATION OF AN IMPERFECT BOSON GAS, by F. H. Kraichnan. [1959] [3]p. (AF 49-638)341 Unclassified

Published in Phys. Fluids, v. 2: 463-465, July-Aug. 1959.

The nature of the Einstein-Bose condensation in an imperfect boson gas is discussed. It is argued that no matter how low the temperature, provided it is not zero, macroscopic second-sound waves should be weakly excited as thermal fluctuations about equilibrium. This implies that the single-particle momentum distribution must be smeared so that the state of zero momentum cannot contain a finite fraction of the particles. A microscopic mechanism which independently leads to a momentum spread is discussed. It is suggested that the actual Einstein-Bose condensation of an imperfect gas takes place in energy rather than momentum but that even in terms of this variable it becomes perfectly sharp only at zero temperature. This hypothesis is formulated analytically in terms of correlation functions of the second-quantized boson field. (Contractor's abstract)

1359

New York U. Inst. of Mathematical Sciences, N. Y.

AN IMPROVED PERTURBATION THEORY FOR SHOCK WAVES PROPAGATING THROUGH NON-UNIFORM REGIONS, by M. P. Friedman. [1959] [17]p. incl. diagrs. (AFOSR-TN-59-603) (AF 49-638)446 AD 250943 Unclassified

Also published in Jour. Fluid Mech., v. 8: 193-209, June 1960.

The problem is considered of the propagation of a shock wave down a non-uniform tube. Linearized solutions to the problem do not hold when the velocity behind the shock is near or at the sonic speed. By retaining appropriate non-linear terms of the flow equations, a solution is obtained which holds for all conditions behind the shock, and reduces to the linearized solution for conditions away from sonic. The behavior of supersonic or subsonic flow entering regions of expanding or contracting area changes is discussed. Subsidiary shocks may be formed; these can be located and described using the present solution. Explicit solutions are given for the cases of supersonic or subsonic flow entering a region of linearly expanding or contracting area. The point of shock formation as well as the path of the subsidiary shock is obtained for the case in which the area contracts. (Contractor's abstract)

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1360

New York U. Inst. of Mathematical Sciences, N. Y.

MOTION OF A BORE OVER A SLOPING BEACH, by H. B. Keller, D. A. Levine, and G. B. Whitham. [1959] [39]p. incl. diagrs. tables. (AFOSR-TN-59-604) (AF 49(638)446) AD 240786 Unclassified

Also published in Jour. Fluid Mech., v. 7: 302-316, Feb. 1960.

The results of numerical calculations are presented for the motion of a bore over a uniformly sloping beach. The shallow water equations are solved in finite difference form, and a technique is developed for fitting in the bore at each step. The results are compared with the approximate formula given by Whitham (1958) and close agreement is found. The approximate theory is considered further here; the main addition is a rigorous proof that, within the shallow water theory, the height of the bore always tends to zero at the shoreline. (Contractor's abstract)

Rabin and R. [B.] Lawhead. Mar. 1959, 47p. incl. illus. diagrs. tables, refs. (Rept. no. R-1503) (AFOSR-TN-59-129) (AF 18(603)98) AD 210768; PB 140621

Unclassified

Studies have been conducted in a 1-in.-sq shock tube to determine the effect of shock waves in the breaking up of burning and non-burning liquid fuel droplets. Experimental data shows the existence of 2 main classes of breakup; a bag-type and a shear-type occurs for both burning and non-burning drops. The type of breakup and the critical velocity required to cause breakup are found to be significantly influenced by the duration of the flow plateau following the shock front; however, as yet, no generalized correlation has been established. The critical velocity for burning drops was found to be slightly lower than for non-burning drops of RP-1, probably due to differences in surface tension. The effect of test section pressure was examined briefly, and it appears that the ratio of critical velocity varies inversely as the 3/4 power of the pressure ratios. Possible application to rocket combustion instability is discussed. (Contractor's abstract)

1361

New York U. [Physics Dept.] N. Y.

SUMMARY OF THE INVESTIGATION OF PERSISTENT INTERNAL POLARIZATION, by [H. Kallman]. June 30, 1958, 15p. (AFOSR-TR-59-19) (AF 18(600)1004) AD 211312 Unclassified

Persistent internal polarization (P.I.P.) is a new phenomena. Before our first experiments, it was only known that polarization fields occurred in photoconductors, but neither their magnitude nor their persistence has been realized. In the early experiments it was established that P.I.P. is due to a displacement of free charges and their freezing in after removal of excitation. Many features of this phenomena were qualitatively determined. P.I.P. is a large macroscopic effect since potentials larger than 1000 v can be stored for long times and readily released thereafter. Therefore, it was felt important to establish a quantitative knowledge of the properties of this phenomena. This has been done from a scientific viewpoint during the last 4 yr.

Nobel Inst. for Neurophysiology, Stockholm (Sweden).
see Karolinska Inst. Nobel Inst for Neurophysiology, Stockholm (Sweden).

1362

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

THE MOTION AND SHATTERING OF BURNING AND NONBURNING PROPELLANT DROPLETS, by E.

1363

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

RESEARCH ON NITRIC ACID-SUPPORTED COMBUSTION, by G. Casaletto, G. Bauerle, and J. Colwell. Final progress rept. Mar. 1959, 61p. incl. illus. diagrs. tables, refs. (Rept. no. R-1157) (AFOSR-TR-59-1) (AF 49(638)163) AD 208301; PB 143916 Unclassified

Details concerning an investigation of nitric acid flames with methane, propane, hydrogen, and acetylene are presented. Flame stability limits, flame speeds, combustion products and emission spectra were studied. (Contractor's abstract)

1364

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

ACCELERATOR DESIGN TECHNIQUES FOR ION THRUST DEVICES, by S. L. Eilenberg. Feb. 1959, 40p. incl. diagrs. (Rept. no. R-1430) (AFOSR-TN-59-194) (AF 49(638)344) AD 211471; PB 139229 Unclassified

The ion rocket engine can be divided, arbitrarily, into 2 major components: the power supply and the ion thrust device. It is assumed that the power supply delivers the required voltage and current with a negligible ripple factor for an unlimited period of time. This report summarizes many of the problems associated with the ion accelerating section of the ion thrust device. Several methods for designing an ion accelerator are discussed, and a specific design calculation is performed. A generalized description of a variety of ion accelerator geometries is presented. (Contractor's abstract)

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1365

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

INVESTIGATION OF DIRECT CONVERSION DEVICES
FOR APPLICATION TO ION PROPULSION, by A. L.
Huebner. May 1959, 40p. incl. diagrs. refs. (Rept. no.
R-1462) (AFOSR-TN-59-461) (AF 49(638)344)
AD 215266 Unclassified

The application of photovoltaic cells to ion propulsion
is discussed. The merit of the photovoltaic cell as a
propulsion device of extremely high reliability is ana-
lyzed. The theory of photovoltaic cells is developed
briefly, and the important parameters affecting the
operation of the cells are discussed, particularly with
respect to conversion efficiency, operating tempera-
ture, and specific weight.

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North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

RADIATION ENVIRONMENT PROBLEM OF A NU-
CLEAR-POWERED ION ROCKET (Unclassified title),
by B. Kimura. June 1959, 37p. incl. diagrs. tables,
refs. (Rept. no. R-1496) (AFOSR-TN-59-594) (AF 49-
(638)344) AD 307801 Secret

A preliminary analysis of the effect of radiation on a
nuclear powered ion rocket is given. The expected ra-
diation intensities due to reactor radiation leakage and
reactor coolant activation are calculated. The conse-
quences of these intensities are to create (1) a severe
heating problem for materials located near the reactor,
and (2) radiation-induced damage problems. Data are
presented illustrating the severity of these problems.
Some idea of the required radiation shielding for pro-
tection of sensitive components located at different po-
sitions relative to the reactor and radiator is given.
(U) (Contractor's abstract)

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North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

ION ROCKET STUDY PROGRAM (Unclassified title).
(n.a.) Final rept. [1959] 97p. incl. diagrs. tables, refs.
(AFOSR-TR-59-99) (AF 49(638)344) Secret

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North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

RECENT DEVELOPMENTS AND DESIGNS OF THE ION
ROCKET ENGINE, by R. H. Boden. [1959] [20]p. incl.

illus. diagrs. table. refs. (Sponsored jointly by Air
Force Office of Scientific Research under [AF 49(638)-
344] and WADC Aeronautical Research Labs.)
Unclassified

Published in Proc. Tenth Internat'l. Astronaut. Con-
gress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959),
Vienna, Springer-Verlag, v. 1: 463-482, 1960.

A brief summary of the basic relationships governing
the operation of electrical propulsion systems is given.
Fundamental design parameters of ion rocket engines
are tabulated for both English and metric systems. The
cross-sectional area of the engine is estimated by con-
sidering a flat-plate electrode configuration and the
modifications imposed on this idealized situation by the
presence of an aperture through which ions are emitted.
The relationship of engine design, vehicle design, and
the mission results from the characteristic velocity re-
quired to accomplish the objective. Methods of mission
analysis are referenced, but not discussed in detail.
The maximum payload for a mission accomplished with
an electrically powered vehicle is estimated from the
data. The limiting thrust-to-weight ratio has been sum-
marized graphically for several types of vehicles in-
cluding ion, plasma, and chemical rockets and modern
aircraft. Comparative maximum payloads of chemical
and ion rockets are presented in terms of the mission
characteristic velocity. The experimental program and
techniques for verifying these analyses on a specific
type of ion rocket engine conceived at Rocketdyne are
presented.

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North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

SECOND AFOSR CONTRACTORS MEETING ON ION
AND PLASMA PROPULSION, Canoga Park, Calif.,
July 8-9, 1959. [1959] 1v. (AFOSR-TN-59-770)
[AF 49(638)351] AD 241053 Unclassified

This report contains 28 abstracts of papers presented
at the meeting. The topics discussed include: (1) cesi-
um ion motor development; (2) analytical studies of ion
propulsion at Rocketdyne; (3) ion propulsion systems;
(4) positive ion surface emission; (5) advanced space
propulsion systems; (6) compact charge exchange ion-
ization; (7) investigation of a charged-colloid propul-
sion system; (8) heavy particle propulsion research;
(9) non-uniform R.F. field acceleration methods for
plasma rockets; (10) ions in rocket combustion prod-
ucts; (11) high pressure plasma production technique;
(12) properties of ions in flames; (13) low temperature
plasma jet as free radical source; (14) heat transfer
from an ionized gas to a gaseous coolant; (15) gasdy-
namics of plasmas; (16) basic studies in magnetohy-
drodynamics; (17) magnetohydrodynamic waves; (8)
heat transfer from high temperature gases using an
electric arc; (19) plasma propulsion with the electro-
magnetic pinch; (20) electromagnetically induced chem-
ical reactions; (21) power generation using a plasma as

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the working fluid; (22) initial breakdown process of gaseous conductors; (23) research on high intensity ionic jets; (24) study of the acceleration and channeling of plasma by magnetic fields; (25) physical properties of high intensity arcs; (26) plasma propulsion; (27) pulsed plasma propulsion; and (28) electromagnetic acceleration of plasma.

1370

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

SUMMARY OF EXPERIMENTAL ION ROCKET PROGRAM FOR THE PERIOD MAY 1, 1958 TO APRIL 30, 1959, by A. T. Forrester and R. C. Speiser. May 1959, 28p. incl. illus. diags. (Rept. no. R-1763) (AFOSR-TN-59-878) (AF 49(638)351) Unclassified

The purpose of this program is to gain an understanding of basic electrical propulsion principles, propellant properties, and ionization and acceleration techniques. Experimental studies were performed on contact ionization ion sources, ion acceleration, and ion beam neutralization. Small research-type devices were successfully operated in ion motor configurations to verify theoretical analysis and to integrate experimental tests on components. The report discusses 2 types of vacuum systems: a bell jar, and a small steel tank. The tank operation proved more versatile, and 2 working variations of the device were built and tested. Instrumentation, fabrication, and neutralization techniques are described, and future work is outlined. (Contractor's abstract)

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North American Aviation Inc. Rocketdyne Div.,
Canoga Park, Calif.

CESIUM ION MOTOR RESEARCH, by R. C. Speiser and C. R. Dulgerff. [1959] [9]p. incl. illus. diags. (AFOSR TN-59-1336) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)351 and Wright Air Development Center under AF 33(616)5027) AD 240986 Unclassified

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct 1959), Boston, v. 1: 179-184, 1959. (AFOSR-63-),

The electrostatic acceleration of ions for the purpose of propulsion is discussed. Small scale experiments with cesium surface ionization devices operated as miniature ion motors are reported. These experiments cover many of the phenomena of significance to the development of practical size ion motors.

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North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

THE ION ROCKET ENGINE, by R. H. Boden. [1959] [11]p. incl. diags. [AF 49(638)351] Unclassified

Presented at SAE Nat'l. Aeronautic Meeting, New York, Apr. 9, 1958.

Published in SAE Trans., v. 67: 227-237, 1959.

The significant design parameters of an ion-propellant rocket engine are developed in terms of 3 independent parameters. These are: the ratio of the acceleration voltage to atomic or molecular weight of the propellant, gross weight of the vehicle, and thrust-to-weight ratio. Engineering trends are presented which will lead toward advanced study of ion thrust chambers, power generation systems, and propellants. (Contractor's abstract)

1373

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

ION ROCKET ENGINE SYSTEMS - A SUMMARY, by R. H. Boden. [1959] [20]p. incl. diags. tables. (AF 49(638)351) Unclassified

Published in Aero/Space Engineering, v. 18: 67-71, Apr. 1959.

The concept of the ion rocket engine which has evolved at Rocketdyne, is 1 of a system which includes 3 major sub-systems - the energy source, the power converter, and the ion thrust chamber. One concept of an ion rocket engine system (electrostatic engine) is summarized. The heart of its thrust producing system is the thrust chamber, which includes an ion source, an array of electrodes to focus and accelerate them, and an electron emitter. This concept, it is believed, will result in an engine of minimum weight and simplicity. Many other concepts which include heat sources other than nuclear, direct power conversion systems, thrust chambers with electromagnetic accelerators in which crossed electromagnetic fields apply the forces to accelerate the ions and electrons, etc., have been conceived and proposed. But after evaluation of design and performance problems associated with these concepts, the most favorable system for development within the next few years appears to be the electrostatic engine. An extensive examination is presented of the 4 major problem areas of the ion rocket engine: (1) the heat source, (2) the power conversion system, (3) the ion thrust chamber, and (4) the propellants.

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North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

CESIUM ION MOTOR DEVELOPMENT (Abstract), by
A. T. Forrester, R. C. Speiser, and D. J. Kerrisk.
[1959] [1]p. (Bound with its AFOSR-TN-59-770;
AD 241053) (AF 49(638)351) Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

In a cesium ion motor the cesium must be transmitted
through a porous aggregate of a material with appropri-
ate physical properties. Some attempts have been made
to use nickel and graphite in this application, but neither
proved as satisfactory as tungsten. With a porous tung-
sten ionizer current densities of 30 ma/cm² were ob-
tained from a surface approx 3/16" in diam at an ionizer
temperature of approx 1500°K. The beam current is
measured to a collector approx 1 ft away from the ion
source and current measurements are supplemented by
2 other measurements on the beam. The beam power is
measured calorimetrically and the thrust is measured
as the steady state displacement of a collector mounted
as a pendulum. Oscillations in the beam current have
been observed at frequencies of approx 100 kc. Neutral-
ization of the ion beam was accomplished by a thermi-
onic electron emitter placed very close to the exit aper-
ture of the ion source. It was observed that the cur-
rent reaching the collector dropped to 0 when the ther-
mionic emitter was heated. At the same time the calor-
imetric collector indicated that the ion beam was un-
changed by the heating of the emitter. While there re-
main several important problems which have not yet
been attacked, e.g. neutral atom efflux and accelerating
electrode erosion, the ion motor continues to appear to
be very promising as a highly efficient propulsion de-
vice for space missions for which high specific im-
pulses are appropriate.

1375

North American Aviation, Inc. Rocketdyne Div.,
Canoga Park, Calif.

ANALYTICAL STUDIES OF ION PROPULSION AT
ROCKETDYNE (Abstract). [1959] [2]p. (Bound with its
AFOSR-TN-59-770; AD 241053) (AF 49(638)649)
Unclassified

Presented at Second AFOSR Contractors meeting on
Ion and Plasma Propulsion, North American Aviation,
Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9,
1959.

Rocketdyne has been engaged in a formal study program
on ion rocket engines under Air Force support since
February 1957. Analytical investigations are currently
being carried out in the areas of power sources, power

converters, electrical generators, ion accelerating
electrode design and mission analysis. In order to study
the influence of electrode geometry on such factors as
the space charge current limitation, sputtering, beam
focusing and beam spreading, an electrolytic tank was
designed and constructed. The tank is modified to simu-
late space charge and uses an analog computer to furnish
ion and electron trajectories. A comprehensive study of
the flight mechanics of low thrust devices in strong grav-
itational fields has recently been completed. Numerous
space flights have been simulated on an IBM-704 com-
puter using an 8-body, 3-dimensional precision integra-
tion program. Work is also being conducted to develop
analytical expressions for low thrust trajectories. A
generalized parametric study of mission analyses has
resulted in the evaluation of a technique whereby, given
a mission and a payload, a relationship may be derived
relating the significant mission parameters to each other.
System components evaluations and turboelectric cycle
studies are being made.

1376

North Carolina U. [Dept. of Chemistry] Chapel Hill.

SELECTIVE POTENTIOMETRIC TITRATION OF MET-
AL IONS WITH TRIETHYLENETETRAMINE, by C. N.
Reilley and M. V. Sheldon. Feb. 1959 [19]p. incl. diagrs.
tables, refs. (Rept. no. UNC-Chem no. 21-CNR)
(AFOSR-TN-59-170) (AF 18(600)1160) AD 211040
Unclassified

Presented at Fifteenth Cong. of the Internat'l. Union
of Pure and Appl. Chem., Lisbon (Portugal), 1956.

Also published in *Talanta*, v. 1: 127-137, July 1958.

See item no. NCU.01:020, Vol. II for abstract.

1377

North Carolina U. [Dept. of Chemistry] Chapel Hill.

TETRAETHYLENEPENTAMINE, 'TETREN,' A SELEC-
TIVE TITRANT FOR METAL IONS, by C. N. Reilley
and A. Vavoulis. Feb. 1959 [19]p. incl. diagrs. tables,
refs. (Rept. no. UNC-Chem. no. 20-CNR) (AFOSR-
TN-59-171) (AF 18(600)1160) AD 211104
Unclassified

Also published in *Anal. Chem.*, v. 31: 243-248, Feb.
1959.

Theoretical and practical considerations demonstrate
that tetraethylenepentamine, as a selective titrant for
metal ions, is superior to triethylenetetramine. The
extent of reaction of tetraethylenepentamine with Hg,
Cu, Ni, Zn, and Cd is discussed quantitatively in rela-
tion to the effect of pH, complex formation, and hydro-
lysis. Potential-pH diagrams obtained using a Hg
electrode offer a simple means of predicting desirable
titration conditions and for detecting the relative

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effect of the various competitive equilibria involved. Titrations of Hg, Cu, Ni, Zn, and Cd alone and in various mixtures were effected using the Hg electrode for potentiometric end point detection. The alkaline earths, rare earths, Al, Bi, Pb, and Sc do not interfere. Hg and Cu can be titrated at low pH in the presence of Ni, Zn, or Cd. In combination with EDTA, a large number of metal ions in multicomponent mixtures may be readily estimated. (Contractor's abstract)

1378

North Carolina U. [Dept. of Chemistry] Chapel Hill.

NEW CHELONS BASED ON PYRIDINE, by D. C. Priest, F. S. Sadek and others. Feb. 1959 [5]p. incl. diagr. (Rept. no. UNC-Chem. no. 22-CNR) (AFOSR-TN-59-172) (AF 18(600)1160) AD 211112 Unclassified

Also published in *Talanta*, v. 2: 275-277, 1959.

Recently the proposal of new chelons (other than the classical EDTA) has permitted many selective titrations. Thus, for example, the polyamines permit selective titrations of the latter transition metals and EGTA (the titration of Ca in the presence of Mg). Another class, derivatives of 2-aminoethyl pyridine-N-N-diacetic acid (PADA) have been synthesized, and the results of the 6-methyl derivative are described in this study. Unlike EDTA, the 6-methyl PADA does not form stable complexes with the alkaline earths and rare earths, that is otherwise similar. Unlike the polyamines, the 6-methyl PADA reacts with Pb and Bi in acid solution. (Contractor's abstract)

1379

North Carolina U. Dept. of Chemistry, Chapel Hill.

ELECTRICAL METHODS OF ANALYSIS, by C. N. Reilley. Final rept. June 1, 1954-June 30, 1958. Aug. 29, 1959, 8p. incl. refs. (AFOSR-TR-59-128) (AF 18(600)1160) AD 227954; PB 144349 Unclassified

A summary is presented of the 4 years of research under this contract in which important progress was made toward understanding of the mechanism of electrode processes and a number of electrochemical methods -- especially those involving chelate reactions -- were developed. Also, several new procedures of analytical value have been discovered. Some of the more important achievements of this research are the following: (1) Proof of the general equation of chronopotentiometry. (2) Recognition of ion pairs as important factors governing reactivity at electrode surfaces. (3) Development of a new principle (via the mercury electrode) for the determination of metal-chelon stability constants. (4) Recognition of the enormous importance of adsorption of surfactants in determining the rates of chemical reactions at electrodes, especially the rates of dissociating metal-complexes. Also important was the recognition of the numerous factors giving rise to

these effects. (5) Development of new high precision colorimetric methods and new methods of indirect spectrophotometry. (6) Discovery of the value of chelons other than EDTA as reagents in analytical chemistry (especially the polyamines and EGTA); also the development of the new indicator "calcon" -- now widely used in the U. S. and in Europe. In addition to these major developments, a great deal of solid progress was made in the description of various reactions and in the accumulation of significant data.

1380

North Carolina U. Dept. of Chemistry, Chapel Hill.

METAL CHELATE STABILITY CONSTANTS OF AMINOPOLYCARBOXYLATE LIGANDS, by J. H. Holloway and C. N. Reilley. Sept. 11, 1959 [28]p. incl. diagrs. tables, refs. (Rept. no. UNC-Chem. no. 2-CNR) (AFOSR-TN-59-748) (AF 49(638)333) AD 226874; PB 144499 Unclassified

Also published in *Anal. Chem.*, v. 32: 249-256, Feb. 1960

The stability constants for the reaction between a series of divalent metal ions with cyclohexanediaminetetraacetic acid (CyDTA), diethylenetriaminepentaacetic acid (DTPA), ethyleneglycol bis-(β -aminoethyl ether)-N,N'-tetraacetic acid (EGTA), ethylenetherdiaminetetraacetic acid (EEDTA), and N-hydroxyethylethylenediaminetriacetic acid (HEDTA) were determined potentiometrically with a mercury electrode. The stability constants for the reaction between lanthanum and diethylenetriaminepentaacetic acid was also determined by the same method. The reported log K values were obtained at $25.00 \pm 0.02^\circ\text{C}$. and at an ionic strength of 0.10. (Contractor's abstract)

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North Carolina U. Dept. of Chemistry, Chapel Hill.

THE CHELON APPROACH TO ANALYSIS, by C. N. Reilley, R. W. Schmid, and F. S. Sadek. Aug. 29, 1959, 54p. incl. diagrs. tables, refs. (Rept. no. UNC-Chem. no. 1-CNR) (AFOSR-TN-59-896) (AF 49(638)333) AD 227955; PB 144879 Unclassified

Also published in *Jour. Chem. Education*, v. 36: 555-564, Nov. 1959; v. 36: 619-626, Dec. 1959.

The stability constants for the reaction between a series of divalent metal ions with cyclohexanediaminetetraacetic acid (CyDTA), diethylenetriaminepentaacetic acid (DTPA), ethyleneglycol bis-(β -aminoethyl ether)-N,N'-tetraacetic acid (EGTA), ethylenetherdiaminetetraacetic acid (EEDTA), and N-hydroxyethylethylenediaminetriacetic acid (HEDTA) have been determined potentiometrically with a mercury electrode. The stability constants for the reaction between lanthanum and diethylenetriaminepentaacetic acid have also been determined by the same method. The complexes studied were

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those of Hg-CyDTA⁻² (log K = 24.4), Ni-CyDTA⁻² (19.4), Zn-CyDTA⁻² (18.6), Ca-CyDTA⁻² (12.3), Sr-CyDTA⁻² (10.6), Hg-DTPA⁻³ (27.0), Zn-DTPA⁻³ (18.8), Cd-DTPA⁻³ (19.0), Mn-DTPA⁻³ (15.5), Pb-DTPA⁻³ (18.6), Ca-DTPA⁻³ (10.7), La-DTPA⁻² (19.1), Hg-EGTA⁻² (23.8), Cu-EGTA⁻² (17.8), Ni-EGTA⁻² (13.6), Co-EGTA⁻² (12.3), Zn-EGTA⁻² (14.5), Cd-EGTA⁻² (16.7), Mn-EGTA⁻² (12.3), Pb-EGTA⁻² (14.6), Ca-EGTA⁻² (10.9), Hg-EEDTA⁻² (23.1), Ni-EEDTA⁻² (14.7), Co-EEDTA⁻² (14.7), Zn-EEDTA⁻² (15.3), Pb-EEDTA⁻² (14.4), Sr-EEDTA⁻² (8.6), Hg-HEDTA⁻¹ (20.1), Zn-HEDTA⁻¹ (14.5), Pb-HEDTA⁻¹ (15.5), Mg-HEDTA⁻¹ (7.0), Sr-HEDTA⁻¹ (6.8), Ba-HEDTA⁻¹ (6.2). The reported log K values were obtained at 25.00 ± 0.02°C and at an ionic strength of 0.10.

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North Carolina U. Dept. of Chemistry, Chapel Hill.

ADSORPTION IN POLAROGRAPHY, by C. N. Reilly and W. Stumm. Oct. 19, 1959 [42]p. incl. diagrs. (Rept. no. UNC-Chem. no. 3-CNR) (AFOSR-TN-59-113) (AF 49(638)333) AD 228463; PB 144383 Unclassified

Surface active substances, even in trace quantities, can exert a marked and often insidious effect on electrode processes. In polarography, adsorption of such substances at the electrode may decrease the limiting current, shift the half wave potential and in some cases obliterate the entire wave. In addition, they can cause minima or deceiving split waves. The characterization of the mode by which these effects arise and how one may detect their origin constitutes the purpose of this discussion. (Contractor's abstract)

1383

North Carolina U. [Dept. of Mathematics] Chapel Hill.

ON THE GREATEST DISTANCE BETWEEN TWO CHARACTERISTIC ROOTS OF A MATRIX, by A. Brauer and A. C. Mewborn. Apr. 1959, 14p. (Technical rept. no. 11) (AFOSR-TN-59-29) (AF 13(603)38) AD 208874; PB 142598 Unclassified

Also published in Duke Math. Jour., v. 26: 653-661, Dec. 1959.

Results for obtaining upper and lower bounds for the greatest distance between 2 characteristic roots of matrices with only real roots and normal matrices are improved and extended to arbitrary matrices. Let $A = (a_{ij})$ be a square matrix of order n with only real roots. Let $f(x) = x^n - c_1 x^{n-1} \dots + (-1)^n c_n = 0$ be its

characteristic equation and $\omega_1 \geq \omega_2 \geq \dots \geq \omega_n$ its characteristic roots. Let K_2 be defined by $K_2 = \{2(1 - 1/n)c_1^2 - 4c_2\}^{\frac{1}{2}}$. Then, for n even, $K_2 \leq \text{Max } |\omega_1 - \omega_j| \leq (2/n)^{\frac{1}{2}} K_2$; and, for n odd, $K_2 \leq \text{Max } |\omega_1 - \omega_j| \leq \{2n/(n^2 - 1)\}^{\frac{1}{2}} K_2$.

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North Carolina U. Dept. of Mathematics, Chapel Hill.

ON STOCHASTIC MATRICES WITH A NON-TRIVIAL GREATEST POSITIVE ROOT, by A. Brauer. Nov. 1959, 8p. (Technical rept. no. 12) (AFOSR-TN-59-933) (AF 18(603)38) AD 237483; PB 148024 Unclassified

Also published in Duke Math. Jour., v. 27: 281-295, Sept. 1960.

The greatest positive characteristic root of an unreduced stochastic matrix A is the trivial root 1. A study is presented of the matrices A which have a non-trivial greatest positive root which is less than the trivial root 1, but greater than or equal to the absolute value of all the other characteristic roots. (Contractor's abstract)

1385

North Carolina U. Dept. of Physics, Chapel Hill.

COVARIANT COMMUTATORS FOR THE QUANTIZED GRAVITATIONAL FIELD, by B. S. DeWitt. Oct. 1959, 7p. (Publication no. 4) (AFOSR-TN-59-1080) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)563 and Institute of Field Physics) AD 226875; PB 144487 Unclassified

The derivation of covariant commutators for the quantized gravitational field provides an important application of the theory of bi-tensor Green's functions. Because of the coordinate invariance of general relativity, well defined commutators can be obtained only if (1) some form of invariant coordinates are introduced, and (2) an explicit expression (can be used to define an arbitrary external source) is found. The 2 requirements are shown to be related.

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North Carolina U. [Inst. of Statistics, Chapel Hill].

COMPLEX REPRESENTATION IN THE CONSTRUCTION OF ROTATABLE DESIGNS, by R. C. Bose and R. L. Carter. [1959] [10]p. (AF 18(600)83) Unclassified

Published in Ann. Math. Stat., v. 30: 771-780, Sept. 1959.

AIR FORCE SCIENTIFIC RESEARCH

Response surface techniques are discussed as a generalization of factorial designs, emphasizing the concept of rotatability. It is shown that the necessary and sufficient conditions for a configuration of sample points to be a rotatable arrangement of a specified order are greatly simplified if, in the case of 2 factors, the factor space is considered as the complex plane. A theorem giving these conditions is proved, with an application to the conditions governing the combination of circular rotatable arrangements into configurations possessing a higher order of rotatability. This is done by showing that certain coefficients must vanish in the "design equation" whose roots are the (complex) values of the various sample points. A method is presented by which any configuration of sample points (for example, some configuration fixed by extra-statistical conditions) may be completed into a rotatable design of the first order by the addition of only 2 properly chosen further sample points. (Contractor's abstract)

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North Carolina U. [Inst. of Statistics] Chapel Hill.

SECOND ORDER ROTATABLE DESIGNS IN THREE DIMENSIONS, by R. C. Bose and N. R. Draper. [1959] [16]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)83 and Office of Naval Research) Unclassified

Published in Ann. Math. Stat., v. 30: 1097-1112, Dec. 1959.

The technique of fitting a response surface is one widely used (especially in the chemical industry) to aid in the statistical analysis of experimental work in which the "yield" of a product depends, in some unknown fashion, on 1 or more controllable variables. Before the details of such an analysis can be carried out, experiments must be performed at predetermined levels of the controllable factors, i.e., an experimental design must be selected prior to experimentation. Methods were needed which would provide both 2nd and 3rd order designs in 3 and more factors. The present work represents an attempt to meet, in part, this need. New construction methods for obtaining rotatable designs of second order in 3 dimensions are here presented. By use of these methods various infinite classes of designs are obtained, and it may be shown that all the rotatable designs previously known can be derived as special cases of these infinite classes. Also derived is an infinite class of 2nd order rotatable designs which contain only 16 points; only 2 particular designs contain fewer points. (Contractor's abstract)

1388

[North Carolina U. Inst. of Statistics, Chapel Hill.]

ASYMPTOTICALLY EFFICIENT TESTS BASED ON THE SUMS OF OBSERVATIONS, by J. H. MacKay. [1959] [8]p. incl. diagrs. [AF 18(600)458] Unclassified

Published in Ann. Math. Stat., v. 30: 806-813, Sept. 1959.

For tests, $\Phi = \{\Phi_k\}$, of composite hypotheses, ω_1 and ω_2 asymptotic efficiency is defined in terms of the behavior as $\alpha \rightarrow 0$ of the sample size N_Φ required to reduce the maximum risk to α . For problems where the ω_1 contain elements θ_1 whose densities satisfy

$$\sup_{\omega_1} \inf_{t>0} E_\theta(t_2/t_1)^t = \inf_t E_1(t_2/t_1)^t = \sup_{\omega_2} \inf_{t<0} E_\theta(t_2/t_1)^t,$$

Chernoff's Theorem 1 is applied to the non-randomized test Φ^* , with $\phi_k^* = 1$ or 0 according as $\sum \log(t_2/t_1) > 0$ or not and proves Φ^* asymptotically efficient. The principal results of the paper are applications of a Theorem to tests of the difference $(\xi - \eta)$ of binomial probabilities with samples of relative size m/n . For $\omega_1 = \{\xi - \eta \leq -\delta\}$, $\omega_2 = \{\xi - \eta \geq \delta\}$, certain tests of the form $\Phi_k^* = 1$ if and only if $\lambda(\xi - \hat{\eta}) > (\hat{\eta} - \frac{1}{2})$, with λ increasing in m/n , turn out to be asymptotically efficient, while all tests of the form $\phi_k = 1, a_k, 0$ according as $(\hat{\xi} - \hat{\eta})$ is greater than, equal to, or less than c_k are asymptotically inefficient when $m \neq n$. For given relative sampling costs, the ratio m/n may be chosen so that the asymptotic cost of observations is minimized. (Contractor's abstract)

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North Carolina U. Inst. of Statistics, Chapel Hill.

MULTI-DIMENSIONAL INCOMPLETE BLOCK DESIGNS, by S. N. Roy and R. F. Potthoff. Nov. 1958, 257p. incl. refs. (Mimeograph series no. 211) (AFOSR-TN-59-68) (AF 49(638)213) AD 209843; PB 140622 Unclassified

The following topics are discussed in detail: analysis of multi-dimensional incomplete block (MDIB) designs for models with no interaction terms; analysis of MDIB designs for models with interaction terms; some examples of MDIB designs and methods of constructing them; and some extensions of the theory of MDIB designs.

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North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON J. ROY'S "STEP-DO" IN PROCEDURE IN MULTIVARIATE ANALYSIS, by V. P. Bhapkar. Dec. 1958, 7p. (Mimeograph series no. 212) (AFOSR-TN-59-69) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 209844; PB 140544 Unclassified

AIR FORCE SCIENTIFIC RESEARCH

The step-down procedure is applied to the multiple independence of normal variates under a general linear model. This procedure was applied to multivariate analysis of variance by Roy in deriving new tests of significance and simultaneous confidence-bounds on a number of deviation-parameters.

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North Carolina U. Inst. of Statistics, Chapel Hill.

SOME NONPARAMETRIC ANALOGUES OF "NORMAL" ANOVA, MANOVA, AND OF STUDIES IN "NORMAL" ASSOCIATION, by S. N. Roy and V. P. Bhapkar. Jan. 1959, 33p. (Mimeograph series no. 215) (AFOSR-TN-59-70) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 209845

Unclassified

Also published in Contributions to Probability and Statistics, Stanford, Stanford U. Press, 1960, p. 371-387.

Hypotheses are proposed which are generalizations appropriate to the set-up of the usual hypotheses in classical normal univariate fixed effects analysis of variance (ANOVA), normal multivariate fixed effects analysis of variance (MANOVA), and in analysis of various kinds of normal independence. Sample tests are offered for such hypotheses. For each (kind of) response or factor, a distinction is made between the structure and the unstructured case, but even for structured factors, the pre-Box treatment is given which avoids the realistic problem of exploring the nature of the dependence of response on the structured factor or factors. Point estimation and confidence bounds on meaningful parametric functions are not discussed separately, nor are the general decision procedures (e.g., ranking, choosing the best, etc.) discussed.

1392

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON CONFIDENCE BOUNDS CONNECTED WITH ANOVA AND MANOVA FOR BALANCED AND PARTIALLY BALANCED INCOMPLETE BLOCK DESIGNS, by V. P. Bhapkar. Jan. 1959, 12p. (Mimeograph series no. 216) (AFOSR-TN-59-88) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 210088; PB 140546

Unclassified

Explicit algebraic expressions are obtained for the total and partial parametric functions that go with the simultaneous confidence statements in the case of both ANOVA and MANOVA and for balanced and partially balanced designs. How to obtain the algebraic expression in a convenient form is considered for the confidence bounds on each such parametric function, without a derivation of these expressions in an explicit form. (Contractor's abstract)

1393

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON A RESULT IN THE THEORY OF CODE CONSTRUCTION, by R. C. Bose and S. S. Shrikhande. Jan. 1959, 16p. incl. refs. (Mimeograph series no. 217) (AFOSR-TN-59-213) (AF 49(638)213) AD 211772; PB 140418

Unclassified

Also published in Inform. and Control, v. 2: 183-194, June 1959.

A connection is established between Hadamard matrices and a problem in the theory of code construction. A square matrix H of order h is called Hadamard matrix H_h , if all its elements are $+1$ or -1 and if any 2 rows (columns) of H are orthogonal. A theorem is proved asserting the co-existence of the maximal codes $M(4t, 2t; 8t)$, $M(4t-1, 2t; 4t)$, where t is any positive integer; the balanced incomplete block design with parameters $v = b = 4t-1$, $r = k = 2t-1$, $\gamma = t-1$; and the Hadamard matrix H_{4t} of order $4t$. The results known up to date are stated regarding the existence of Hadamard matrices and the corresponding balanced incomplete block designs. The structure is studied of the maximal codes $M(4t-2, 2t; 2t)$, $M(4t-1, 2t; 4t)$, and $M(4t, 2t; 8t)$. (ASTIA abstract)

1394

North Carolina U. Inst. of Statistics, Chapel Hill.

CONTRIBUTIONS TO UNIVARIATE OR MULTIVARIATE ANALYSIS OF VARIANCE WITH FIXED EFFECTS, NORMAL OR NONNORMAL RANDOM EFFECTS, AND NORMAL ERROR, by S. N. Roy and W. Cobb. Jan. 1959, 133p. incl. diagr. refs. (Mimeograph series no. 214) (AFOSR-TN-59-217) (AF 49(638)213) AD 211779; PB 140355

Unclassified

The theory of variance components analysis is extended to include univariate models with nonnormal random components and multivariate models with fixed, normal, or nonnormal random components. In the multivariate model, confidence bounds are obtained on some functions (characteristic roots) of the variance matrices when the block effects are normal, but without the restriction that the variance matrices of these block effects are proportional to the variance matrix of the normal error. An investigation is made to remove from the model (univariate or multivariate) the stipulation that the random components are normally distributed and still obtain confidence bounds on some measure of the dispersion of these random components, e.g., the interquartile difference if not the variance. The study aims to remove from the model, restrictive assumptions, including its designation as an ANOVA (analysis of variance) model or a variance components model. For each unobservable of the model, a statistic is obtained which can be used in the analysis of variance,

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or in components of variance analysis, regardless of whether other unobservables of the model are fixed or random. (ASTIA abstract)

1395

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE FALSITY OF EULER'S CONJECTURE ABOUT THE NON-EXISTENCE OF TWO ORTHOGONAL LATIN SQUARES OF ORDER $4t+2$, by R. C. Bose and S. S. Shrikhande. Preliminary rept. Mar. 1959 [6]p. incl. tables. (Mimeograph series no. 220) (AFOSR-TN-59-277) (AF 49(638)213) AD 212711; PB 140629
Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 734-737, May 1959.

A general theorem is proved on the existence of pairwise orthogonal Latin squares (p. o. l. s.) of a given order. A counter example is given to Euler's conjecture that there do not exist 2 p. o. l. s. of order $4t+2$. (Contractor's abstract)

1396

North Carolina U. Inst. of Statistics, Chapel Hill.

A NOTE ON TESTING VARIOUS KINDS OF ASSOCIATION UNDER A MULTIVARIATE NORMAL LINEAR MODEL, by S. N. Roy. Mar. 1959, 5p. (Mimeograph series no. 221) (AFOSR-TN-59-384) (AF 49(638)213) AD 214191
Unclassified

Assume the following model: $\frac{X}{pxm} = \frac{\xi}{pxm} \frac{A}{mxn} + \frac{\epsilon}{pxn}$,

where $\frac{\epsilon}{pxn} = [\epsilon_1, \epsilon_2, \dots, \epsilon_n]$, the ϵ_i 's ($i = 1, 2, \dots, n$) are

supposed to be a set of n independent p -dimensional

stochastic vectors, each being $N\left[\frac{0}{pxl}, \frac{\Sigma}{pxp}\right]$, A is the

structure matrix determined from the design of the experiment and the model, and ξ at this stage is assumed to be a set of unknown parameters associated with fixed effects. Assume, without any loss of generality, that $\text{rank}[A] = r \leq m \leq n-p$. Under this model, procedures are set up for testing various types of hypothesis on Σ that one poses and tests under a model

in which $\frac{X}{pxn}$ is supposed to be a set of n independent and identically distributed stochastic p -vectors, each being an $N\left[\frac{\xi}{pxl}, \frac{\Sigma}{pxp}\right]$. (Contractor's abstract)

1397

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE CONSTRUCTION OF SETS OF PAIRWISE OR-

THOGONAL LATIN SQUARES AND THE FALSITY OF A CONJECTURE OF EULER, by R. C. Bose and S. S. Shrikhande. Apr. 1959, 31p. incl. diagrs. refs. (Mimeograph series no. 222) (AFOSR-TN-59-401) (AF 49(638)213) AD 214521; PB 142723
Unclassified

Also published in Trans. Amer. Math. Soc., v. 95: 161-225, May 1960.

Methods are generalized for constructing pairwise orthogonal Latin squares (p.o.l.s.) by showing that a general class of designs, called pairwise balanced designs of index unity, can be used for the construction of sets of p.o.l.s. Various applications of this method are made. Euler's conjecture, the non-existence of 2 orthogonal Latin squares of order v when $v \equiv 2 \pmod{4}$, is shown to be false for an infinity of values of v , including all values of the form $36m + 22$. A table is given for all values of $v \leq 150$, for which the method shows that $N(v) > n(v)$; $N(v)$ being the max possible number of Latin squares of order v and $n(v)$ the max possible number of p.o.l.s. The smallest number which demonstrates the falsity of Euler's conjecture is 22. The appendix contains 2 orthogonal squares of order 22 constructed by this method.

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North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE CONSTRUCTION OF PAIRWISE ORTHOGONAL SETS OF LATIN SQUARES AND THE FALSITY OF A CONJECTURE OF EULER, II, by R. C. Bose and S. S. Shrikhande. May 1959, 13p. incl. table. (Mimeograph series no. 225) (AFOSR-TN-59-518) (AF 49(638)213) AD 216239; PB 143028
Unclassified

The study is continued on the construction of pairwise orthogonal sets of Latin squares and the falsity of a conjecture of Euler previously reported (item no. 1397 Vol. III). Under satisfying conditions, the proof of the theorem on the existence of a pairwise balanced design of index unity is augmented. Improvements on the lower bounds for $(N(v))$ are obtained. A demonstration shows that at least 2 orthogonal Latin squares of order v exist for $v > 6$ except for $v = 14$ and 26.

1399

North Carolina U. Inst. of Statistics, Chapel Hill.

INCOMPLETE BLOCK DESIGNS IN WHICH THE NUMBER OF REPLICATES IS NOT THE SAME FOR ALL TREATMENTS, by L. C. A. Corsten. May 1959, 20p. incl. tables. (Mimeograph series no. 226) (AFOSR-TN-59-580) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213, Institute for Research on Varieties of Field Crops in the Netherlands, and Netherlands Organization for Pure Research) AD 217027
Unclassified

Construction is considered of incomplete block designs

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in which the treatments have not all the same number of replicates, but which still have a certain degree of symmetry, usually indicated with the term balance. Considered are the case in which the treatments have either r_1 or r_2 replicates ($r_1 < r_2$), which are called rare and frequent treatments respectively. (Contractor's abstract)

1400

North Carolina U. Inst. of Statistics, Chapel Hill.

CONTRIBUTIONS TO THE STATISTICAL ANALYSIS OF EXPERIMENTS WITH ONE OR MORE RESPONSES (NOT NECESSARILY NORMAL), by V. P. Bhapkar. July 1959, 123p. incl. refs. (Mimeograph series no. 229) (AFOSR-TN-59-795) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)213 and Office of Naval Research under Nonr-85506) AD 219882
Unclassified

Experimental data are considered which are given in the form of frequencies in cells determined by a finitely multi-way cross-classification, with predefined categories, finite in number, along each way of classification. Hypotheses are imposed which are considered to be generalizations appropriated in (1) classical normal univariate fixed effects analysis of variance (ANOVA), (2) normal multivariate fixed effects analysis of variance (MANOVA), and (3) analysis of various kinds of normal independence. Sample tests are given for these hypotheses. Two theorems on minimum χ^2_1 are proved, and the univariate 2-factor problems are studied. The 2-way classification test is extended to cover incomplete block situations. An extension of the U-statistics theorem is stated and proved, and a new test-criterion for the problem of c samples is given. Some regression problems and some bivariate problems in the non-parametric set-up are studied. Most of the test-criteria developed are asymptotic in nature. (ASTIA abstract)

1401

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE APPLICATION OF THE GEOMETRY OF QUADRICS TO THE CONSTRUCTION OF PARTIALLY BALANCED INCOMPLETE BLOCK DESIGNS AND ERROR CORRECTING BINARY CODES, by D. K. Ray-Chaudhuri. June 1959, 125p. incl. diagrs. tables, refs. (Mimeograph series no. 230) (AFOSR-TN-59-796) (AF 49(638)213) AD 235092
Unclassified

A brief systematic treatment of the theory of quadrics in finite projective geometry is presented, and some new results in the theory of quadrics are derived. Several properties of the polar spaces are proved. The explicit formulas for the number of p-flats contained in nondegenerate quadrics in $PG(n,s)$, the finite projective geometry of n dimensions based on a Galois field $GF(s)$,

are obtained. The canonical forms for the elliptic and hyperbolic nondegenerate quadric and several properties of the nucleus of polarity of a nondegenerate quadric in $PG(2k, 2^m)$ are given. A general method of constructing Partially Balanced Incomplete Block Designs is developed. Several new PBIB designs with r and k not greater than 10 are contained in 1 section. A theorem is proved about PBIB designs with 3 associate classes which gives a much less demanding definition of PBIB design with 3 associate classes. Two series of such designs are obtained. A set of points in $PG(m,2)$ to be a R_t -set if no t

points of the set lie in a (t-2)-flat. It is proved that there exists a t-error correcting binary (n,k)-group codes with n places and k information places if, and only if, $N_{2^t}(n-k-1) \geq n$.

1402

North Carolina U. Inst. of Statistics, Chapel Hill.

ON THE COMPOSITION OF BALANCED INCOMPLETE BLOCK DESIGNS, by R. C. Bose and S. S. Shrikhande. [1959] [12]p. [AFOSR-TN-59-840] (AF 49(638)213)
Unclassified

Also published in Canad. Jour. Math., v. 12: 177-186, 1960.

An orthogonal array (N, k, s, t) of size N, k constraints, s levels, strength t and index λ is a $k \times N$ matrix whose elements are taken from the integers $1, \dots, s$ such that every t rowed submatrix contains every t-plet exactly λ times as a column. The authors first derive by construction lower bounds on the number k of constraints if $t = 2$. The construction depends on the existence of another configuration termed pairwise balanced designs of index λ . The authors then confine a composition procedure for balanced incomplete block designs by which a BIB $(v_1, v_2, k, \lambda_1, \lambda_2)$ under certain conditions also a $(v_1(v_2 - 1) + 1, k, \lambda_1, \lambda_2)$ can be obtained from a (v_1, k, λ_1) and a (v_2, k, λ_2) . Various refinements and modifications of this method are given by which resolvable designs and BIB designs with other specified properties can be obtained. Finally BIB designs with $k = 5, \lambda = 1$ and $k = 4, \lambda = 1$ are constructed when v satisfies certain arithmetical conditions. The results are very numerous and interesting. It is however impossible to cram into a review all the definitions needed for a precise formulation of the results. (Math. Rev. abstract)

1403

North Carolina U. Inst. of Statistics, Chapel Hill.

ON A CLASS OF ERROR CORRECTING BINARY GROUP CODES, by R. C. Bose and D. K. Ray-Chaudhuri. Sept. 1959, 14p. incl. tables. (Mimeograph series no. 240) (AFOSR-TN-59-1240) (AF 49(638)213) AD 235094
Unclassified

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Also published in Inform. and Control, v. 3: 68-79, Mar. 1960.

A general method of constructing error correcting binary group codes is obtained. A binary group code with k information places and n places is called an (n,k) code. Explicit methods of constructing t -error correcting (n,k) codes are given for $n = 2^m - 1$ and $k = 2^{m-1} - 1$ for general t . An example is worked out to illustrate the method of construction. (Contractor's abstract)

1404

North Carolina U. [Inst. of Statistics] Chapel Hill.

ORTHOGONAL LATIN SQUARES AND EULER'S CONJECTURE, by R. C. Bose, S. S. Shrikhande, and E. T. Parker. [1959] 34p. incl. diagrs. tables, refs. [Mimeograph series no. 245] (AFOSR-TN-59-1241) (AF 49-638)213 AD 235095 Unclassified

A Latin square of order n is defined as an $n \times n$ square, the n^2 cells of which are occupied by n distinct symbols such that each symbol occurs exactly once in each row and once in each column. Two Latin squares are said to be orthogonal if, on superposition, each symbol of the 1st square occurs exactly once with each symbol of the 2nd square. Euler conjectured that there does not exist a pair of orthogonal Latin squares of order $n = 4t + 2$, for any positive integer t . Successive steps are traced for which a complete solution of the problem of constructing a pair of orthogonal Latin squares of any order $4t + 2$, $t \geq 1$, was achieved. Counterexamples to Euler's conjecture are also given.

1405

North Carolina U. [Inst. of Statistics, Chapel Hill].

EQUALITY OF MORE THAN TWO VARIANCES AND OF MORE THAN TWO DISPERSION MATRICES AGAINST CERTAIN ALTERNATIVES, by R. Gnanadesikan. [1959] [8]p. [AF 49(638)213] Unclassified

Published in Ann. Math. Stat., v. 30: 177-184, Mar. 1959.

In this paper, using the heuristic union-intersection principle, 2 tests are proposed, and the associated simultaneous confidence bounds on parametric functions which are measures of a certain type of departure from the respective null hypotheses are obtained. The 1st test is for the equality of $(k + 1)$ variances ($k \geq 2$) of $(k + 1)$ univariate normal populations, wherein one of the variances is a standard (of course, unknown), is chosen and compared with the other k variances. The alternative to the hypothesis is that not all the k variances are equal to the standard one. The proposed test may be called the simultaneous variance ratios test. The well-known Hartley's F_{\max} test for the case of equal sample sizes is not equivalent to the present test

even when all samples are of the same size since the alternatives in the 2 cases are different. In the alternative in Hartley's test, aside from the inequality of the k variances to the standard one, the mutual inequality of the k variances also plays an important role. The 2nd test proposed in this paper, is a multivariate extension of the 1st. This paper also considers the distribution problems that arise in connection with both the tests. The nonavailability of tables at the moment makes the immediate practical application of the tests and the associated confidence bounds not possible. (Contractor's abstract)

1406

North Carolina U. [Inst. of Statistics, Chapel Hill].

A SIMPLE MINIMUM-AVERAGE-RISK PROCEDURE FOR THE MULTIPLE COMPARISONS PROBLEM (Abstract), by D. B. Duncan. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)213] and Public Health Service) Unclassified

Presented at meeting of the Inst. of Math. Stat., Pittsburgh, Pa., Mar. 19-21, 1959.

Published in Ann. Math. Stat., v. 30: 621-622, June 1959.

Let $[y_1, \dots, y_n, s]$ be a sufficient estimator for $[\mu_1, \dots, \mu_n, \sigma]$ such that, to take a typical simple case, $[y_1, \dots, y_n]$ is normally distributed with mean $[\mu_1, \dots, \mu_n]$ and variance σ^2 , and s^2 is the usual form of independent estimate (with ν degrees of freedom) for σ^2 . Let T represent the class of $n(n - 1)$ differences $T = \{\tau: \tau = (\mu_i) / \sqrt{2\sigma}; i, j = 1, \dots, n; i \neq j\}$. The sub-set system of the multiple comparisons problem considered is that formed as the restricted product of the 2-decision component-problem subset pairs $\tau > 0, \tau \leq 0$ for all $\tau \in T$. A Bayes solution is developed for each component problem. Their simultaneous application, all $\tau \in T$, is shown to be the Bayes solution to the given multiple comparisons problem with respect to a loss function formed as the sum of the component loss functions and to a Bayes function having the component Bayes functions at its margins. A table of t is used for each component solution, the test statistic now also being a function of the residual variance among the y 's and having $\nu + n - 2$ instead of ν degrees of freedom.

1407

North Carolina U. [Inst. of Statistics, Chapel Hill].

SOME CONTRIBUTIONS TO ANOVA IN ONE OR MORE DIMENSIONS: I, by S. N. Roy and R. Gnanadesikan. [1959] [14]p. incl. refs. [AF 49(638)213] Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Published in *Ann. Math. Stat.*, v. 30: 304-317, June 1959.

Two models are considered in detail which are the Models I and II of ANOVA in the terminology of Eisenhart. The present paper, which deals with the 1 dimensional or univariate case, and its sequel, which will deal with the multidimensional or multivariate case, seek to give a unified general treatment, using matrix methods, of certain problems under the 2 models of ANOVA. Section 1 of each paper, which deals with Model I, is of the nature of a résumé giving the main results of a general treatment. Section 2 of each paper, which deals with Model II or variance components model, is self-contained, and presents a natural tie-up between the analyses under the 2 models for a k-way classification. Results in estimation, testing of hypotheses and confidence bounds are presented, although the main emphasis is on the results in confidence bounds (simultaneous and/or separate) on meaningful parametric functions which are physically natural and mathematically convenient measures of departure from customary null hypotheses. It is shown that a mixed model, which would include both Models I and II as special cases, can be defined, and the associated problems can be studied by using methods which are, essentially, a combination of the methods given for the separate models in Sections 1 and 2, respectively, of this paper. (Contractor's abstract)

1408

North Carolina U. [Inst. of Statistics, Chapel Hill].

SOME CONTRIBUTIONS TO ANOVA IN ONE OR MORE DIMENSIONS: II, by S. N. Roy and R. Gnanadesikan. [1959] [23]p. incl. refs. [AF 49(638)213]

Unclassified

Published in *Ann. Math. Stat.*, v. 30: 318-340, June 1959.

This paper presents certain natural extensions, to the multi-dimensional or multivariate situation, of the results contained in another paper (item no. 1407, Vol. III). The same notation as before is used and, in addition, the following notation is added: $c(A)$ will denote all the characteristic roots of the matrix A , and if A is at least positive semi-definite, then $c_{\min}(A)$ and $c_{\max}(A)$ will denote, respectively, the smallest and the largest of these roots; $D_a(p \times p)$ will denote a diagonal matrix whose elements are a_1, a_2, \dots, a_p ; $\tilde{T}(p \times p)$ will denote a triangular matrix whose non-zero elements are along and below the diagonal; $|A|$ will denote the determinant of a square matrix A ; and $A(p \times p) \cdot x B(q \times q)$ will denote the Kronecker product or right direct product of the matrices A and B . Also $\min(p, q)$ will denote the lesser of the two real numbers p and q . (Contractor's abstract)

1409

North Carolina U. [Inst. of Statistics] Chapel Hill.

MOMENTS OF ORDER STATISTICS FROM A NORMAL POPULATION, by R. C. Bose and S. S. Gupta. [1959] [8]p. incl. tables, refs. [AF 49(638)213]

Unclassified

Published in *Biometrika*, v. 46: 433-440, Dec. 1959.

This paper deals with the problem of obtaining the moments of $X_{(k)}$, the k th order statistic for a sample of size n from a normal population $N(0, 1)$. It has been shown that $\mu'_t(n, k)$, the t th moment of $X_{(k)}$, can be expressed in terms of lower moments of order $t - 2l$ ($l = 1, 2, \dots, \frac{t}{2}$ or $\frac{t-1}{2}$) and the integral

$$(1) \int_{-\infty}^{+\infty} P_{t+1}(x) e^{-\frac{1}{2}(t+1)x^2} dx,$$

where $P_{t+1}(x)$ for $t > 0$, is defined by

$$(2) P_{t+1}(x) = k \binom{n}{k} \frac{d}{d\phi} [\phi^{k-1} (1 - \phi)^{n-k}],$$

it being understood that in (2), ϕ is replaced after differentiation by $\Phi(x)$, the cumulative distribution function (c.d.f.) of $N(0, 1)$. $P_t(x)$ is thus a polynomial of degree $(n-t)$ in $\Phi(x)$ if $t \leq n$ and is zero if $t > n$. Exact values of all odd order moments can be derived when $n < 5$, and the exact values of all even order moments can be derived when $n < 6$. The exact moment tables for $t = 3$ and 4 are provided in this paper. In general the numerical evaluation of the integral (1) can be expeditiously done by using the Gauss method of numerical integration based on the zeros and the weight factors of the Hermite-polynomials.

1410

North Carolina U. Inst. of Statistics, Chapel Hill.

MINIMUM BIAS ESTIMATION, by W. J. Hall. Dec. 1958, 21p. incl. refs. (Mimeograph series no. 213) (AFOSR-TN-59-215) (AF 49(638)261) AD 211777; PB 142677

Unclassified

Presented at annual meeting of the Amer. Stat. Assoc., Chicago, Ill., Dec. 27, 1958.

This is an expository paper on the theory and application of minimum bias estimation, an approach to estimation theory which characterizes an estimator primarily according to its bias. Minimum risk theory leads to estimators which minimize the average risk on the maximum risk. The place of bias in the risk theory is reinterpreted, and an alternative theory is developed with the risk function replaced by a bias function. When the unbiased estimators do not exist, the average or the maximum of the bias function is minimized by choosing an unbiased estimator of a suitable approximation to the function to be estimated.

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Relevant aspects of the theory of approximation are reviewed. Estimators which minimize the maximum absolute bias are shown to minimize also the average squared bias, the average being taken with respect to a least favorable prior distribution. The problem of estimating a root of the binomial parameter, arising in certain biological and military applications, is used to exemplify various aspects of the minimum bias theory.

1411

North Carolina U. Inst. of Statistics, Chapel Hill.

AN OPTIMUM PROPERTY OF SOME BECHHOFFER AND SOBEL NON-SEQUENTIAL MULTIPLE-DECISION RULES, by W. J. Hall. Nov. 1958, 8p. (Mimeograph series no. 210) (AFOSR-TN-59-216) (AF 49-638)261 AD 211778; PB 140590 Unclassified

Presented at meeting of the Inst. Math. Stat., Ames, Iowa, Apr. 3-5, 1958.

Abstract published in Ann. Math. Stat., v. 29: 621, June 1958.

Proof is presented of the following theorem: Let $\{\theta_i\}$, $\theta_i \in R_1$, be a homogeneous class of density functions w.r.t. a fixed measure. Let $\{X_{ij}\}$ ($i = 1, 2, \dots, m$; $j = 1, 2, \dots, n$) denote mn independent random variables where X_{ij} has the density function f_{θ_i} , $\theta_i \in \Omega$, $i = 1, \dots, m$, and let $\theta_{(1)} \leq \dots \leq \theta_{(m)}$ be the ordered values of the θ_i 's. Denote $\underline{\theta} = (\theta_1, \dots, \theta_m)$. Suppose $t_1 = t_1(x_{11}, \dots, x_{1n})$ is a numerical sufficient statistic for θ_1 , that t_1 has a monotone likelihood ratio, and that θ_1 is a location parameter in the induced distribution of t_1 ($i = 1, \dots, m$). Let D_n denote any decision rule for choosing which θ_i is $\theta_{(m)}$ based on an observation on the mn random variables $\{X_{ij}\}$, and let D_n^0 denote that D_n which chooses as the largest of the m θ_i 's the one corresponding to the largest of the t_1 's. Suppose N is the least n for which $\int F_n^{m-1}(t + \delta) dF_n(t) \geq \gamma$ ($\delta > 0$, $0 < \gamma < 1$) where $F_{\theta,n}(t) = F_n(t - \theta)$ is the c.d.f. of t with parameters θ and n. Then D_N^0 satisfies the following: (a) $\Pr\{\text{correct decision using } D_n^0 | \underline{\theta}\} > \lambda$ for all $\underline{\theta}$ for which $\theta_{(m)} - \theta_{(m-1)} > \delta$ and (b) there does not exist decision rule D_n satisfying (a) with $n < N$. (ASTIA abstract)

1412

North Carolina U. Inst. of Statistics, Chapel Hill.

A SIMPLE BAYES SOLUTION TO A COMMON MULTIPLE COMPARISONS PROBLEM, by D. B. Duncan. Apr. 1959, 38p. incl. diagrs. table, refs. (Mimeograph series no. 223) (AFOSR-TN-59-492) (Sponsored jointly by Air Force Office of Scientific Research under AF 49-638)261. Office of Naval Research under Nonr-85506, and Public Health Service) AD 215396 Unclassified

The problem is discussed of making the $n(n-1)/2$ simultaneous 2-sided symmetric t tests of the $n(n-1)/2$ hypotheses $H: \mu_i = \mu_j$, $i, j = 1, \dots, n$; $i < j$. The more mathematical aspects of a comprehensive Bayes analysis of the problem is presented. The closeness of a seemingly useful adaptation of the Bayes rule and the least-significant-difference rule of Fischer is demonstrated.

1413

North Carolina U. Inst. of Statistics, Chapel Hill.

TWO-STAGE EXPERIMENTS FOR ESTIMATING A COMMON MEAN, by D. L. Richter. June 1959, 15p. (Mimeograph series no. 231) (AFOSR-TN-59-793) (AF 49-638)261 AD 225090 Unclassified

Also published in Ann. Math. Stat., v. 31: 1164-1173, Dec. 1960.

Let π_1, π_2 be 2 normal populations with common mean μ and variances σ_1^2, σ_2^2 , where the parameter values are unknown. Suppose that it is desired to estimate μ , and that the experimental procedure is to take m observations from each population, compute variance estimates, and then take $n - 2m$ observations from that population with the smaller observed variance, where n has been fixed beforehand. Let $R_n(\theta, m) = V_0^{-1} E(\hat{\mu} - \mu)^2$ be the risk of the estimator $\hat{\mu}$, where $V_0 = n^{-1} \min(\sigma_1^2, \sigma_2^2)$ and where $\theta = \sigma_2^2/\sigma_1^2$. For a class of "best" estimators, it is shown in this paper that $\sup_{\theta} R_n(\theta, m) \rightarrow 1$ as $n \rightarrow \infty$ if and only if $m/n \rightarrow 0$ and $n \rightarrow \infty$ as $n \rightarrow \infty$; that $\min_m \sup_{\theta} R_n(\theta, m) \sim 1 + Cn^{-1/3}$ as $n \rightarrow \infty$; and that the minimax sample size is $m \sim Cn^{2/3}$ as $n \rightarrow \infty$. (Contractor's abstract)

1414

North Carolina U. Inst. of Statistics, Chapel Hill.

ON SUFFICIENCY AND INVARIANCE WITH APPLICATIONS IN SEQUENTIAL ANALYSIS, by W. J. Hall. June 1959, 21p. incl. diagr. refs. (Mimeograph series no. 228) (AFOSR-TN-59-794) (AF 49-638)261 AD 235091; PB 148239 Unclassified

AIR FORCE SCIENTIFIC RESEARCH

An investigation is made to determine in what sense sufficiency properties are preserved under the invariance principle. Thus an interpretation is obtained of the sufficiency of a statistic in the presence of nuisance parameters. It is shown that if a statistic, s , contains all relevant information about a parameter, then the maximal invariant function of s contains all the relevant information about the function of that parameter that is available in any invariant function. It is also shown that knowing the mean parameter and variance, the magnitude of the sample mean as an invariantly sufficient statistic can be obtained by invoking invariance under changes in sign. Similarly, with normal mean and variance unknown, the sample variance is invariantly sufficient for the population variance under changes in location, and the t -statistic is invariantly sufficient for the mean in standard deviation units under changes in scale; with 2 normal populations with equal and known variances, the difference between the sample means is invariantly sufficient for the difference between population means under changes in location.

1415

North Carolina U. Inst. of Statistics, Chapel Hill.

LOWER BOUNDS FOR THE EXPECTED SAMPLED SIZE AND THE AVERAGE RISK OF A SEQUENTIAL PROCEDURE, by W. Hoeffding. June 1959, 29p. incl. table, refs. (Mimeograph series no. 227) (AFOSR-TN-59-800) (AF 49(638)261) AD 235093 Unclassified

Also published in Ann. Math. Stat., v. 31: 352-368, June 1960.

Also published in Information and Decision Processes, N. Y., McGraw-Hill, 1960, p. 53-61.

Lower bounds are considered for the expected sample size $E_0(N)$ of an arbitrary sequential test whose error probabilities at 2 parameter points, θ_1 and θ_2 , do not exceed given numbers α_1 and α_2 , where $E_0(N)$ is evaluated at a 3rd parameter point θ_0 . The bounds are shown to be attainable or nearly attainable in certain cases where θ_0 lies between θ_1 and θ_2 . Lower bounds for the average risk of a general sequential procedure are obtained. (Contractor's abstract)

1416

North Carolina U. [Inst. of Statistics, Chapel Hill].

THE MOST-ECONOMICAL CHARACTER OF SOME BECHHOFFER AND SOBEL DECISION RULES, by W. J. Hall. [1959] [6]p. (AF 49(638)261) Unclassified

Published in Ann. Math. Stat., v. 30: 964-969, Dec. 1959.

Justification is given for the use of a wide range of procedures for choosing particular populations. These choices guarantee a correct decision with prescribed probability when the extreme population parameter is sufficiently distinct from the others. This paper proves that no other rules can meet this guarantee with a smaller (fixed) sample size. Proof of this most-economical character of these rules is achieved by proving their minimax character when a suitable loss function is introduced.

1417

North Carolina U. Psychometric Lab., Chapel Hill, N. C.

BAYES ESTIMATION OF PROPORTIONS: THE EFFECT OF STIMULUS DISTRIBUTION AND EXPOSURE TIME, by E. H. Shuford and R. A. Wiesen. Dec. 1959, 16p. incl. tables, refs. (AFOSR-TN-59-1311) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)729 and National Institutes of Health) AD 232826 Unclassified

Twenty-three undergraduate students estimated the percentage of 1's in random matrices composed of 1's and 0's in varying proportions. The 2 types of information were experimentally varied by using different stimulus distributions and exposure times. The subjects were not told what the stimulus distribution would be and, thus, had to learn the stimulus probabilities during the course of the experiment. The decision-theoretic model, fitted to the data of each subject, yields estimates of 3 parameters -- 2 pertaining to the subjective stimulus probabilities, the other reflecting the effect of changes in exposure time. The estimates of the majority of the subjects were affected by changes in stimulus distribution and exposure time and were in agreement with the Bayes strategy interpretation. The ability of the model to predict subsequent behavior was quite dependent upon the way a subject interpreted the situation, e.g., some subjects, instead of learning the new stimulus distribution, assumed that the previous distribution was being presented and their subjective stimulus probabilities displayed a "gambler's fallacy" effect. Most subjects used an all-or-none, rather than a squared error, performance criterion. (Contractor's abstract)

1418

Northwestern U. Dept. of Chemistry, Evanston, Ill.

BRIDGED MECHANISM FOR THE PLATINUM (II) CATALYSIS OF CHLORIDE EXCHANGE IN CHLOROAMINE PLATINUM (IV) COMPLEXES, by M. L. Morris, F. Basolo, and R. G. Pearson. Nov. 20, 1959 [26]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1225) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)315 and Atomic Energy Commission under AT(11-1)89) AD 232954; PB 145844 Unclassified

AIR FORCE SCIENTIFIC RESEARCH

A kinetic study was made of the platinum (II) catalyzed chloride ion exchange of various chloroammineplatinum (IV) complexes. The exchange was observed to follow the rate law $R = k[\text{Pt (IV)}][\text{Pt (II)}][\text{Cl}^-]$ and to be essentially the same as the rate of platinum exchange.

The rate of chloride exchange with trans- $\text{Pt}(\text{NH}_3)_4\text{Cl}_2^{2+}$ is about 2,000 times faster than with the cis isomer and about 10,000 times faster than with $\text{Pt}(\text{NH}_3)_5\text{Cl}^{3+}$. There is no chloride exchange in the system trans- $\text{Pt}(\text{tetraammine})_2\text{Cl}_2^{2+} - \text{Pt}(\text{tetraammine})_2^{2+} - \text{Cl}^-$.

All of these observations are explained on the basis of a 2 electron change redox reaction involving a bridged activated complex. (Contractor's abstract)

1419

Northwestern U. Dept. of Chemistry, Evanston, Ill.

LINKAGE ISOMERISM. SYNTHESIS AND ISOMERIZATION OF NITRITOPENTAMMINE COMPLEXES OF RHODIUM (III) AND IRIIDIUM (III), by F. Basolo and G. S. Hamaker. Nov. 20, 1959, 3p. (Bound with its AFOSR-TN-59-1225; AD 232954) (AF 49(638)315) Unclassified

Published in Jour. Amer. Chem. Soc., v. 82: 1001-1002, Feb. 20, 1960.

The successful synthesis of $\text{Rh}(\text{NH}_3)_5\text{ONO}^{2+}$ and $\text{Ir}(\text{NH}_3)_5\text{ONO}^{2+}$ salts and their isomerization complexes is reported. Their acquisition is a good example of the use of reaction mechanisms to prepare new compounds. It was thought that a low energy reaction path should be available to form the compounds similar to that of the N_2O_3 or NO^+ on the oxygen of $\text{Co}(\text{NH}_3)_5\text{OH}^{2+}$ to form $\text{Co}(\text{NH}_3)_5\text{ONO}^{2+}$. It was found that the stable nitro compound is sufficiently slow that the reaction at mild conditions yields the kinetic nitrito product. It is reported that at elevated temperatures the reactions of $\text{Rh}(\text{NH}_3)_5\text{OH}^{2+}$ and $\text{Ir}(\text{NH}_3)_5\text{OH}^{2+}$ with NO_2^- produce salts of $\text{Rh}(\text{NH}_3)_5\text{NO}_2^{2+}$ and $\text{Ir}(\text{NH}_3)_5\text{NO}_2^{2+}$, but at ice-bath temperatures similar mixtures produced salts of $\text{Rh}(\text{NH}_3)_5\text{ONO}^{2+}$ and $\text{Ir}(\text{NH}_3)_5\text{ONO}^{2+}$ instead. The presence of M-ONO linkage was verified and its rate of isomerization to M- NO_2 followed by an examination of the infrared spectra of the solid compounds.

1420

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

THE DISTRIBUTION OF A GENERALIZED D_n^+ STA-

TISTIC, by M. Dwass. [1959] 7p. (AFOSR-TN-59-38) (AF 49(638)151) AD 209210 Unclassified

Also published in Ann. Math. Stat., v. 30: 1024-1028, Dec. 1959.

Let $F_n(x)$ be the sample c.d.f. for a sample of size n from the continuous population c.d.f. $F(x)$. Elementary derivations are given of the exact distribution of $\sup_{-\infty \leq x \leq \infty} [F_n(x) - cF(x)]$, where $c > 0$.

1421

Northwestern U. [Dept. of Mathematics] Evanston, Ill.

AVERAGES OF FOURIER COEFFICIENTS, by R. R. Goldberg. [1959] [5]p. (AFOSR-TN-59-647) (AF 49(638)383) AD 230020 Unclassified

Also published in Pacific Jour. Math., v. 9: 695-699, 1959.

The author proves that if $\psi(x)$ is of bounded variation in the interval $0 \leq x \leq 1$, and (a_n) is the sequence of Fourier coefficients of L^p function, then the sequence $\{1/n \sum_{m=1}^n \psi(m/n)a_m\}$ ($n = 1, 2, \dots$) is also. The case $\psi(x) = 1$ was proved by G. H. Hardy (Messenger of Math., v. 58: 50-52, 1929). (Math Rev. abstract)

1422

Northwestern U. Dept. of Mathematics, Evanston, Ill.

THE ISOPERIMETRIC INEQUALITY AND ASSOCIATED BOUNDARY PROBLEMS, by W. T. Reid. Dec. 1958, 11p. (Technical rept. no. 1) (AFOSR-TN-59-2) (AF 49(638)400) AD 208182 Unclassified

Also published in Jour. Math. and Mech., v. 8: 897-905, Nov. 1959.

The extremal property of the smallest proper value of the boundary problem $\eta'' + \lambda\eta = 0$, $\eta(0) = 0$, $\eta(L) = 0$, is used to present an elementary proof of the isoperimetric inequality $4\pi A \leq L^2$ for a simple closed plane curve of length L and enclosed area A . With the aid of this extremal property there is established also an integral inequality for simply connected rectifiable pieces of regular surfaces, which in turn provides an elementary proof of the result of Carleman [Math. Zeitschr., 9: 154-160, 1921] that the isoperimetric inequality persists for such pieces of minimal surfaces. The extremal property of the smallest proper value of a related boundary problem is shown to afford a similar proof of the modified isoperimetric inequality for the simplest instance of a plane variational problem of Dido type. (Contractor's abstract)

1423

Northwestern U. Dept. of Mathematics, Evanston, Ill.

EXISTENCE THEOREMS FOR CERTAIN CLASSES OF TWO-POINT BOUNDARY PROBLEMS BY VARIATIONAL METHODS, by R. J. Driscoll. Mar. 1959, 37p. (Technical rept. no. 2) (AFOSR-TN-59-254) (AF 49-638)400 AD 212254; PB 142297 Unclassified

Also published in Pacific Jour. Math., v. 10: 91-115, 1960.

Existence theorems are established for the solutions of 2 classes of differential systems by the variational methods. The 1st system considered is of the form: $y''(x) = f[x, y(x), y'(x)]$ for $a \leq x \leq b$, and $y(a) = y_1$ and $y(b) = y_2$, where $f(x, y, z)$ is a real vector function of the real scalar x and the real n -dimensional vectors $y \equiv (y_j)$ and $z \equiv (z_j)$, ($j = 1, 2, \dots, n$). In conjunction with this system, a functional $l(y, z)$ is considered which is defined over a suitable class of pairs of vector functions $[y(x), z(x)]$ satisfying $y(a) = y_1$ and $y(b) = y_2$. The 2nd system considered is of the form: $y''(x) = g_y[x, y(x)]$ for $0 < x < \infty$, and $y(0) = y_0$ for $y(x)$ bounded on $0 < x < \infty$ where $g(x, y)$ is a real scalar function of the real scalar x and the n -dimensional vector y , and $g_y(x, y)$ denotes the vector $g_{y_j}(x, y)$. The functional $l(y)$ is considered in conjunction with the 2nd system for which y'' is the related Euler equation. $l(y, z)$ is shown to have the absolute minimum zero, so that if $y_0(x), z_0(x)$ minimizes $l(y, z)$, then $y = y_0(x)$ is a solution of the 1st system. Under suitable hypotheses, $l(y)$ is shown to have a minimizing function which is the unique solution of the 2nd system.

1424

Northwestern U. Dept. of Mathematics, Evanston, Ill.

ON THE APPROXIMATION OF INTEGRABLE FUNCTIONS BY FUNCTIONS OF BOUNDED VARIATION, by W. T. Reid. Aug. 1959, 8p. (Technical rept. no. 4) (AFOSR-TN-59-825) (AF 49(638)400) AD 227581; PB 144375 Unclassified

Also published in Ann. Scuola Norm. Super. Pisa Sci. Fis. e Mat., Series III, v. 14: 133-140, 1960.

Proof is presented of the following theorem: suppose that $y(x) \equiv (y_\alpha(x))$, ($\alpha = 1, \dots, n$), is (Lebesgue) integrable on the closed interval (a, b) , and of bounded variation on an extension closed interval (b, d) . If L is the infimum $\Lambda(a, b; z) \equiv L(a, b; z) + |z(b) - y(b^+)|$ for $z \in E(y)$, then: (1) $L < \infty$ if and only if $E_{bv}(y)$ is non-empty; (2) h^{-1}

$\int_a^b |y(x^+ h) - y(x)| dx = L$ as $h \rightarrow 0^+$; and (3) if $L < \infty$ then $z_+(x) = \lim_{h \rightarrow 0} h^{-1} \int_0^h y(x^+ s) ds$ exists on (a, b) and:

(i) $z_+ \in E_{bv}(y)$; (ii) z_+ is right-hand continuous on (a, b) and $z_+(b) = y(b^+)$; (iii) $\Lambda(a, b; z_+) = L(a, b; z_+) = L$; and (iv) if $z \in E_{bv}(y)$ and $\Lambda(a, b; z) = L$, then $z(a) = z_+(a)$ and for $a < x < b$ there is a $\Theta(x)$ such that $0 < \Theta(x) < 1$ and $z(x) = (1 - \Theta(x))z_+(x^-) + \Theta(x)z_+(x)$.

1425

Northwestern U. Dept. of Mathematics, Evanston, Ill.

PROPERTIES OF SOLUTIONS OF A RICCATI MATRIX DIFFERENTIAL EQUATION, by W. T. Reid. Aug. 1959, 28p. incl. refs. (Technical rept. no. 3) (AFOSR-TN-59-826) (AF 49(638)400) AD 227560; PB 144497 Unclassified

Also published in Jour. Math. and Mech., v. 9: 749-770, Sept. 1960.

The study of the properties of the solutions of Riccati matrix differential equations is continuing. The analytic methods of a previous article (item no. 1422) are shown to yield properties presented by Redheffer (Jour. Rational Mech. and Anal., v. 5: 835-848, 1956; Math. Ann. v. 133: 235-250, 1957). Certain of the results presented are formed to establish the existence of solutions, rather than to postulate their existence. The improved result involves an extension of a quadratic form problem. Special attention is given to Riccati equations arising as the Legendre equation for a variational problem. The methods are shown to provide the main theorem on the Mycielski-Paszowski diffusion problem.

1426

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

FURTHER STUDIES OF GPI ZONE FORMATION IN Al-2 AT.% Cu, by C. Chiou, H. Herman, and M. E. Fine. June 2, 1959 [34]p. incl. diagrs. tables, refs. (AFOSR-TN-59-509) (AF 18(600)1468) AD 216274; PB 142038 Unclassified

Presented at meeting of the Amer. Inst. Metall. Engineers, Chicago Ill., Nov. 2-5, 1959.

Also published in Trans. Metall. Soc. AIME, v. 218: 299-306, Apr. 1960.

The effects were investigated of varying the solution treating procedure and the concentration of quenched-in vacancies on the growth kinetics of Guinier-Preston zones of the first kind (GPI). Dynamic Young's modulus was studied in single crystal specimens. The dynamic method for measuring Young's modulus

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incorporated longitudinal vibrations that were excited and detected electrostatically. As aging proceeded, the specimen's fundamental and natural frequency of longitudinal vibration (resonant frequency) increased. The variables that were investigated for direct aging were solution temperature (515° and 550°C) and quenching speed (oil and water quenching). Data indicated that grain boundaries do not appear to have a significant effect on the kinetics of formation of zones occurring at room temperature. The kinetics was also about the same for specimens with a circular cross-section of 0.18 in. diameter and rectangular cross-section of 0.21 by 0.055 in. The magnitude of the change in Young's modulus varied with crystallographic direction. The hardness change during aging was not orientation dependent over the range that was studied. The initial rate of aging was slower after oil quenching, but this was reversed at later times. The rate of aging was greater for oil quenching at longer times. Final hardness was considerably less for the oil quench. (Contractor's abstract)

1427

Northwestern U. Dept. of Metallurgy and Materials
Science, Evanston, Ill.

THE PLASTIC DEFORMATION OF SINGLE CRYSTALS OF AN ALUMINUM-SILVER ALLOY, by A. Kelly, A. Lassila, and S. Sato. [1959] [18]p. incl. illus. diags. tables, refs. (AFOSR-TN-59-719) (AF 18(600)1468) AD 239913 Unclassified

Also published in Philos. Mag., v. 4: 1260-1277, Nov. 1959.

Tensile tests have been carried out at a variety of temperatures between 77°K and 373°K on single crystals of an aluminum-20 wt % silver alloy. The crystals were aged either at room temperature, or at 160°C, within the cold-hardening range. Single crystals of this material are very ductile. Stress-strain curves have been obtained, and the change of flow stress with temperature (during deformation) has been measured and compared with the change of modulus over the same temperature range. Observations have been made with the optical microscope of the appearance of slip lines on polished surfaces of the specimens. The stress-strain curves are approximately linear showing a rate of work hardening about the same as that of pure aluminum in stage II of the stress-strain curve. The temperature dependence of the flow stress is small, varying less than does the elastic modulus over the temperature range investigated. The temperature dependence of the flow stress is compared with new measurements of the same quantity in pure aluminum single crystals. The crystals deform by a $\langle 100 \rangle \{111\}$ slip mechanism but cross slip is profuse at all stages of the deformation and at all temperatures. This is attributed to the very high flow stress of these single crystals which is 2 orders of magnitude greater than that shown by pure aluminum. (Contractor's abstract)

1428

Northwestern U. Dept. of Metallurgy and Materials
Science, Evanston, Ill.

AN INVESTIGATION OF PHASE TRANSFORMATIONS AND OTHER STRUCTURAL CHANGES IN METALS BY MEASUREMENT OF ELASTICITY AND INTERNAL FRICTION, by M. E. Fine and A. Kelly. Final rept. June 1, 1955-Aug. 31, 1959. Sept. 30, 1959 [50]p. incl. diags. tables, refs. (AFOSR-TR-59-141) (AF 18(600)1468) AD 227686; PB 144008 Unclassified

Dynamic elasticity and internal friction apparatus were built for ranges of 77° to 1075°K and 20 to 200 kc. The high temperature apparatus using electrostatic excitation and detection embodied a number of improvements. In addition, apparatus using piezoelectric quartz crystals was set up. Measurement of dynamic Young's modulus was used to study the kinetics and mechanism of formation of Guinier-Preston (GP) zones from supersaturated solid solution in Al-base Cu alloys, and Al-base Ag alloys; atomic arrangements in AuCu₃, and α -brass; and the hexagonal-to-cubic transformation in Co. In addition, the Young's modulus and internal friction of a number of metals were measured at elevated temperatures, and an acoustic relaxation effect in Mn₃O₄ was studied. A theoretical and experimental study of the strength and plasticity of age-hardened Al alloys was undertaken. Since theory seems to indicate that GP zones are sheared during deformation, an x-ray study of the effect of deformation on size and shape of zones in Al-base Ag alloys using low-angle scattering was made. Much of the research involved use of single crystals, and various methods were developed for growing these from Al-base Ag, Cu, and Zn alloys.

1429

Northwestern U. Dept. of Metallurgy and Materials
Science, Evanston, Ill.

ELECTRICAL RESISTIVITY CHANGE FROM FORMATION OF ZONES IN ALUMINUM ALLOYS, by M. E. Fine. [1959] 3p. (AFOSR-4025) (AF 18(600)1468) Unclassified

Also published in Acta Metall., v. 7: 228-229, Mar. 1959.

An analysis of the processes taking place during zone aging of aluminum alloys is presented. It can be concluded that 2 main resistivity effects are occurring in Al-Cu alloys: (1) a decrease in resistivity due to a reduction in Cu concentration in the solid solution, and (2) an increase due to the presence of zones. In these alloys the atomic diameters are 2.856Å and 2.551Å, respectively. The mismatch, created by the 12% difference in diameter size, must be taken up by some means. It is suggested that the zones contain extra rows of copper atoms, of which each row could be

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thought of as a pair of edge dislocations of opposite sign in the matrix. The increase in resistivity would be due to scattering of electrons by the extra rows of atoms as well as the lattice strains in the matrix. Calculations are presented which tend to substantiate this hypothesis.

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Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

TEMPERATURE DEPENDENCE OF THE STRENGTH OF ZONE HARDENED ALUMINUM-SILVER ALLOYS, by M. E. Fine. [1959] 4p. Incl. table. (AFOSR-4026) (AF 18(600)1468) Unclassified

Also published in Philos. Mag., v. 4: 1375-1377, Dec. 1959.

The principal source of the strength of aluminum-rich silver alloys containing Guinier-Preston zones has been attributed to chemical changes associated with shearing of zones during plastic deformation. The purpose of this note is to point out that there is also an increase in entropy resulting from shearing of zones and to discuss the temperature dependence of the flow stress due to the entropy term. The configurational entropy per atom in a zone is very small and negligible compared to the configurational entropy of an atom in the matrix solid solution. The entropy of mixing of the zones in the matrix solid solution may also be neglected. The average change in free energy due to removing an atom from a zone and placing it into solution can be calculated, and from that the free energy change may be put on the per atom of silver basis. The results are presented in table form and show that the computed temperature variation is only qualitative. It is concluded that the entropy consideration may be important in determining the temperature variation of the flow stress in this alloy.

1431

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

THE STRENGTHENING BY PRECIPITATES IN Al-Cu ALLOYS (Abstract), by J. G. Byrne, A. Kelly, and M. E. Fine. [1959] [1]p [AF 18(600)1468] Unclassified

Presented at meeting of the Amer. Inst. Metall. Engineers, Chicago, Ill., Nov. 2-5, 1959.

Single crystals of Al-3.85% Cu were water quenched from the solid solution range and aged at various times and temperatures to produce the various known precipitates GPI, GPII, θ' and θ . Measurements were made of the critical resolved shear stress and the temperature dependence of the flow stress at a variety of temperatures between 77°K and 373°K. Stress-

strain curves were obtained and the temperature dependence of the rigidity modulus of this alloy in various aged states were measured. Crystals containing GPI zones and crystals containing θ' and θ precipitates respectively show a temperature dependence of the strength greater than that shown by crystals containing GPII zones. The effect of long aging times on the critical resolved shear stress at 77°K and 273°K was investigated. Tensile testing of single crystals containing the various precipitates, at liquid helium temperatures, is underway. Comparison of the temperature dependence of the flow stress of these crystals with that of the elastic constants enables a critical appraisal of theories of age hardening to be made.

1432

Northwestern U. [Dept. of Metallurgy and Materials Science] Evanston, Ill.

CONTRIBUTION OF DISLOCATION LINE TENSION AND THE DENSITY OF THE SOLUTE ATMOSPHERE TO THE YIELD POINT IN STRAIN AGED INGOT IRON, by J. O. Brittain and T. Mura. Aug. 7, 1959 [23]p. incl. diagrs. refs. (AFOSR-TN-59-760) (AF 18(600)1598) AD 225736; PB 143620 Unclassified

Also published in Acta Metall., v. 8: 767-772, Nov. 1960.

An investigation was made of the 77°K yielding behavior of ingot iron specimens that had been prestrained and aged while under stress at 303°K. It was observed that the presence of a yield point at 303°K after a strain aging treatment does not result in a yield point at 77°K until the strain aging treatment is prolonged so as to result in an increase in the 303°K yield point on about 20%. The sharpness and magnitude of the yield point at about 303° and 77°K increased with an increase in the aging time and/or an increase in the stress which was maintained upon the specimen during the aging treatment. The observations of the effect of the aging time and aging stress are discussed in terms of the contribution of the dislocation line tension and solute atmosphere density along the dislocation. (Contractor's abstract)

1433

Northwestern U. Dept. of Metallurgy and Materials Science, Evanston, Ill.

KINETICS OF SINTERING OF SODIUM CHLORIDE IN THE PRESENCE OF AN INERT GAS, by D. H. Whitmore and J. B. Moser. Nov. 19, 1959 [24]p. incl. diagrs. table, refs. (AFOSR-TN-59-1256) (AF 49(638)436) AD 231157; PB 145644 Unclassified

Also published in Jour. Appl. Phys., v. 31: 488-496, Mar. 1960.

Direct observations of interfacial growth and the approach of centers between spheres of NaCl were made

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in an Ar atm and over a temperature range of 700-900°C. The rate law governing the increase of the contact area between spheres, the effect of changing size scale on this rate and the absence of a change in the center-to-center distance during sintering all indicate that the rate-determining mechanism of material transport in this sintering process is evaporation-condensation. A model is presented which considers Stefan flow to occur within a thin boundary layer in the gaseous phase adjacent to the condensing surface, the sintering rate being predominantly governed by the rate at which sodium chloride vapor diffuses through this boundary layer. The marked pressure-dependence of the empirical relationship between contact area and sintering time for fixed temperature and sphere size is consistent with the proposed model. (Contractor's abstract)

1434

Norway Technical U. Inst. for Theoretical Chemistry, Trondheim.

AN ELECTRON DIFFRACTION INVESTIGATION OF THE MOLECULAR STRUCTURE OF ALLENE, by A. Almenningsen, O. Bastiansen, and M. Traetteberg. Aug. 31, 1959, 9p. incl. diagrs. tables. (AFOSR-TN-59-704) (Also bound with its AFOSR-TN-59-905; AD 226434) (AF 61(052)72) AD 230376; PB 145611 Unclassified

Also published in Acta Chem. Scand., v. 13: 1699-1702, 1959.

The electron diffraction sector method was used to determine the structure of allene vapor. The observed molecular parameters are the following: C-H: 1.081₆ Å (u = 0.0795A), C-H: 1.311₆ Å (u = 0.0390A), C₁C₃: 2.617 Å (u = 0.0519A) and < H-C=C:

120.8°. The C₁C₃ distance was found to be shorter than twice the C=C distance. This can be explained by out-of-linearity vibrations. (Contractor's abstract)

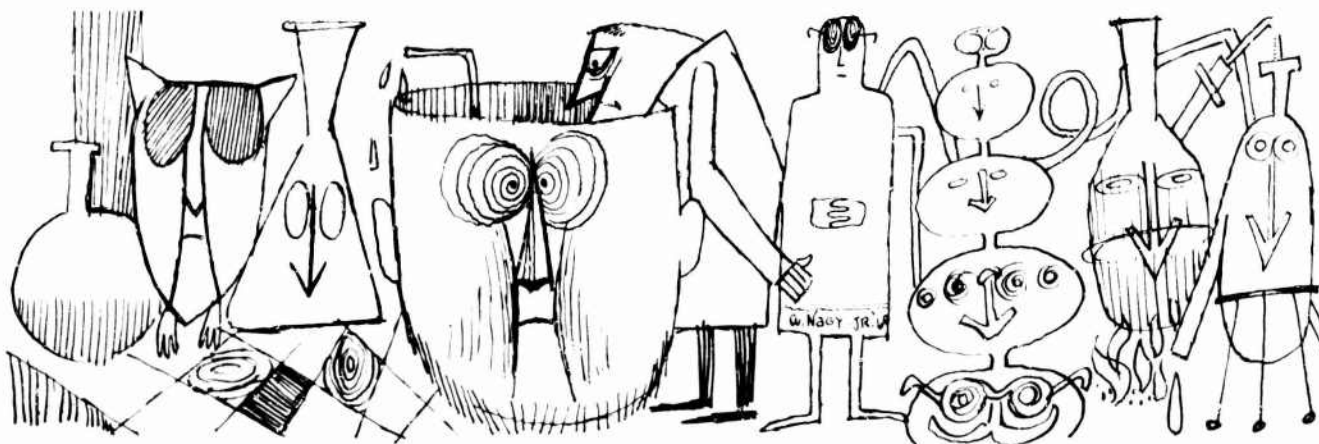
1435

Norway Technical U. Inst. for Theoretical Chemistry, Trondheim.

PART I. AN ELECTRON DIFFRACTION INVESTIGATION OF THE MOLECULAR STRUCTURE OF ALLENE. PART II. ELECTRON DIFFRACTION STUDIES OF THE MOLECULAR STRUCTURE OF NAPHTHALENE AND CORONENE IN THE VAPOR STATE. PART III. PRELIMINARY ELECTRON DIFFRACTION STUDIES OF BUTATRIENE, by A. Almenningsen, O. Bastiansen and others. Annual Technical rept. Apr. 1, 1958-June 30, 1959. July 24, 1959, 1v. incl. diagrs. tables, refs. (AFOSR-TN-59-905) (AF 61(052)72) AD 226434; PB 146183 Unclassified

Part I also published in Acta Chem. Scand., v. 13: 1699-1702, 1959.

Part I. See item no. 1434, Vol. III for abstract. Part II. A least-squares refinement procedure was applied to the data obtained from the radial distribution curve. A least-squares refinement of naphthalene was applied to the intensity curve. Observed structural models of coronene and naphthalene were compared with those from x-ray studies. Part III. Electron diffraction diagrams of butatriene were taken at 3 distances between diffraction point and the photographic plate. The 1st experimental molecular intensity curve was obtained from these diagrams. The 1st radial-distribution curve was obtained by using intensity values up to s = 45 Å⁻¹; the 1st structural model was made from the radial distribution curve. (Contractor's abstract)



AIR FORCE SCIENTIFIC RESEARCH

1436

Ohio State U., Columbus.

INPUT DISTORTION AND OBSERVER OVERLAP IN DECISION-MAKING, by J. S. Kidd and F. Boyer. [1959] [9]p. incl. diagr. tables. (AFOSR-TN-59-161) (AF 49-638)236 AD 264401 Unclassified

Also published in Management Sci., v. 6: 123-131, Oct. 1959.

A realistic decision-making situation was developed based on the simulation of a tactical military operation. A 3-man team comprised the work unit; 2 acted in an information-processing role and 1 was assigned an information-integration and decision-making function. Differential levels of information input distortion and observer overlap were compared. It was found that input distortion degrades decision-making speed and accuracy and that the increased intensity of coverage provided by observer-overlap did not moderate this effect. Detailed analysis of the activities associated with the information-processing function were also made. The findings were interpreted in terms of both theoretical and methodological issues. (Contractor's abstract)

1437

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

AN INVESTIGATION OF THE TRANSFORMATION AND STRUCTURE OF SILVER MERCURIC IODIDE, by C. E. Olsen and P. M. Harris. Aug. 1959, 61p. incl. diagrs. tables, refs. (Technical rept. no. 2) (AFOSR-TN-59-756) (AF 18(600)769) AD 229755; PE 156106 Unclassified

Single crystals of Ag_2HgI_4 were grown from solution. They undergo transformation at $\sim 51^\circ\text{C}$ without shattering. The transformation at 51° clearly shows that the initial phase obtained from solution is not again obtained. Transitions are shown from β' phase at less than 51°C , α phase from 51°C to 157°C , and β phase back to less than 51°C . The unit cell of the β' -phase contains 2 molecules Ag_2HgI_4 ideally and is tetragonal with $a = 6.32\text{\AA}$, $c = 12.64\text{\AA}$, $c/a = 2$ exactly. It is body-centered with $\bar{4}$ symmetry. Evidence is adduced supporting the hypothesis that the β' crystals are non-stoichiometric and exhibit iodine vacancies with a portion of the silver ions in interstitial sites. The β -phase obtainable from the α -phase appears to have a cubic, primitive cell, $a = 12.64\text{\AA}$. (Contractor's abstract)

1438

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

LAUE-BRAGG SCATTERING AND CHARGE DISTRIBUTION

IN LITHIUM HYDRIDE, by T. J. Phillips and P. M. Harris. Sept. 1959, 39p. incl. diagrs tables, refs. (Technical rept. no. 3) (AFOSR-TN-59-757) (AF18-600)769 AD229758; PB 156107 Unclassified

Intensities of Laue-Bragg scattering from single crystals of LiH were obtained at room temperature and at approximately 100°K , using an x-ray spectrometer equipped with either a Geiger-Müller counter or proportional counter detector. Values of relative crystal structure factors, F_{hkl} , and relative atomic form factors were derived from the measured intensities. Absolute crystal structure factors were determined by 2 different experimental methods: the use of a crystal monochromator in conjunction with a Geiger-Müller counter detector, and the use of a proportional counter detector with energy discrimination. Electron density distributions were computed for LiH from the absolute structure factors. Radial charge distributions were computed from the electron density distributions. The experimental crystal structure factors were found to be in better agreement with an ionic model with overlap than with either a neutral atom model or a separated ion model. (Contractor's abstract)

1439

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

RESEARCH ON SOLID-STATE PROPERTIES OF METALLIC CERAMIC AND ELECTRONIC MATERIALS, by P. M. Harris. Final rept. Sept. 1959, 7p. (AFOSR-TR-59-109) (AF 18(600)769) AD 228575; PB 152014 Unclassified

The work covered and reported in Technical Reports No. 1: (OSU-05: 003, Vol. I), No. 2: (item no. 1437, Vol III) and No. 3: (item no. 1438, Vol. III) is briefly summarized. Additional work initiated but not yet completed and being presently prosecuted is also reviewed.

1440

Ohio State U. [Research Foundation] Dept. of Chemistry, Columbus.

GAS-LIQUID CHROMATOGRAPHIC ANALYSIS OF SOME OXYGENATED PRODUCTIONS OF COOL-FLAME COMBUSTION, by G. Kyriacos, H. R. Menapace, and C. E. Boord. [1959] [4]p. incl. diagrs (AF 18(600)787) Unclassified

Published in Anal. Chem., v. 31: 222-225, Feb. 1959.

This work was carried out to understand better the mechanism of hydrocarbon combustion through separation and identification of the intermediates formed in cool-flame oxidation by means of gas chromatography. Compounds hitherto unidentifiable have been separated and identified: ethylene oxide, propionaldehyde, acetone,

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acrolein, cis- and trans-2,5-dimethyltetrahydrofuran, n-butyraldehyde, methyl ethyl ketone, methyl vinyl ketone, 2-ethyl tetrahydrofuran, methanol, and crotonaldehyde. (Contractor's abstract)

1441

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

STRUCTURES OF TRINITRO-AROMATIC CRYSTALS AND RELATED SUBSTANCES, by P. M. Harris. Final rept. Sept. 1959 [63]p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-165) (AF 18(600)1371) AD 228781; PB 156104 Unclassified

Determinations were made of the molecular and crystal structures of trinitro-derivatives of benzene and related explosives, including sym-trinitrobenzene, RDX, TNT, picryl chloride, and lead styphnate.

1442

Ohio State U. Research Foundation. Dept. of Chemistry, Columbus.

THE VAPORIZATION OF RARE EARTH OXIDES, by P. N. Walsh, H. W. Goldstein, and D. White. [1959] [19]p. incl. diagr. tables, refs. (AFOSR-TN-59-706) (AF 18(600)1545) Unclassified

Presented at 61st annual meeting of the Amer. Ceramic Soc., Chicago, Ill., May 19, 1959.

Also published in Jour. Amer. Ceram. Soc., v. 43: 229-233, May 1, 1960.

A study of the vaporization of La_2O_3 , Nd_2O_3 , and Y_2O_3 at high temperatures has been carried out by the Knudsen effusion technique. The methods employed, the results of these measurements, and the low temperature heat capacities of these materials, which were determined for the purpose of calculating thermal functions of the oxides, are discussed. All the above oxides react with tantalum, forming gaseous tantalum monoxide as a principal product. Cubic tantalates of lanthanum and neodymium are also formed in these reactions. Dissociation energies of the monoxides of tantalum and the rare earth metals are given. Based on this information some generalizations about the vaporization behavior to be expected of other rare earth oxides are formulated. (Contractor's abstract)

1443

Ohio State U. [Research Foundation] [Dept. of Chemistry] Columbus.

NEW REACTIONS ON DECOMPOSITION OF A

HINDERED α -DIAZOKETONE, by M. S. Newman and A. Arkell. [1959] [3]p. incl. diagrs. refs. (AFOSR-190) (AF 33(616)3412) Unclassified

Also published in Jour. Org. Chem., v. 24: 385-387, Mar. 1959.

A new procedure for the conversion of monohydrazones of α -diketones to α -diazoketones by oxidation of the hydrazone with mercuric trifluoroacetate in acetonitrile in the presence of triethylamine is described. The rearrangements of 4-diazo-2,2,5,5-tetramethyl-3-hexanone under several conditions are described. The main product of these rearrangements is 2,2,4,5-tetramethyl-4-hexen-3-one, a product in which a methyl migration has occurred. (Contractor's abstract)

1444

Ohio State U. [Research Foundation. Dept. of Chemistry] Columbus.

REARRANGEMENT OF 4-METHYL-4-TRICHLORO-METHYL-2,5-CYCLOHEXADIENOLS, by M. S. Newman, J. Eberwein, and L. L. Wood, Jr. [1959] [3]p. incl. refs. (AFOSR-TN-59-1077) (AF 49(638)-277) Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6454-6456, Dec. 20, 1959.

It is shown that in 2 cases in which a trimethyl group was reported to undergo a 1:2-shift, errors in identification of products were made. 4-Methyl-1-phenyl-4-trichloromethyl-2,5-cyclohexadienol (I) yields 4-methylbiphenyl (II) on treatment with cold formic acid, and 2,6-dichloro-4-methyl-4-trichloromethyl-2,5-cyclohexadienol (VIII), yields 3,5-dichloro-2-methylbenzoic acid (X) on treatment with a solution of sulfuric acid in acetic acid at reflux. (Contractor's abstract)

1445

Ohio State U. [Research Foundation. Dept. of Chemistry] Columbus.

REACTIONS OF 2,5-CYCLOHEXADIENONES CONTAINING THE TRICHLOROMETHYL GROUP, by M. S. Newman and L. L. Wood, Jr. [1959] [5]p. incl. refs. (AFOSR-TN-59-1078) (AF 49(638)277) Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6450-6454, Dec. 20, 1959.

The synthesis of 3,4-dimethyl-4-trichloromethyl-2,5-cyclohexadienone (III) is described. On treatment with phosphorus pentachloride, III yields 4-methyl-3-(β,β,β -trichloroethyl)-chlorobenzene (IV). On treatment of III with polyphosphoric acid, 2-chloro-4,5-dimethylbenzoic acid (V) and 2-chloro-5,6-dimethylbenzoic acid (VI) are formed in addition to a small amount of 3,4-dimethylchlorobenzene (VII). Treatment

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of 4-methyl-4-trichloromethyl-2,5-cyclohexadienone (I) with the same reagents yields 3-methyl-4-trichloromethylchlorobenzene and 4-chloro-2-methylbenzoic acid (VII) (plus a little *p*-chlorotoluene (IX)), respectively. Mechanisms are proposed to account for these facts. (Contractor's abstract)

1446

Ohio State U. Research Foundation. Dept. of Electrical Engineering, Columbus.

ANALYTICAL STUDY ON THE TRANSVERSE FIELD TRAVELING-WAVE TUBES, by F.-S. Chen. July 1959, 114p. incl. diagrs. tables, refs. (Technical note no. 5) (AFOSR-TN-59-985) (AF 18(600)982) AD 228321; PB 156108 Unclassified

It is known that transverse-field traveling-wave tubes have a low noise figure when the beam is well collimated. The present analysis shows in detail the properties of the slow-wave structure, the electronic motion, and the mechanism of energy exchange between the electron beam and the traveling wave from which gain, noise figure, and frequency response are evaluated. The proposed tube has a slow-wave structure composed of 2 flat helices, each of them wound on a conducting metal plate but insulated from it. By properly exciting the 2 helices, a transverse field is obtained between them. Direct potential is applied between the helices and the metal plates for periodic electrostatic focusing of the electron beam. The analysis of the slow-wave structure shows that 2 fundamental slow-wave modes can be excited. The propagation constants and the interaction impedances of the 2 modes are calculated. Also the field configuration in the various regions of the slow-wave structure is shown. (Contractor's abstract, modified)

1447

Ohio State U. [Research Foundation]. Dept. of Physics [and Astronomy] Columbus.

COMPUTATION OF ASYMMETRIC ROTATOR CONSTANTS FROM ENERGY MOMENTS. III. FIRST-ORDER CENTRIFUGAL STRETCHING EFFECTS, by P. M. Parker and L. C. Brown. [1959] [4]p. incl. diagr. table. (AFOSR-TN-59-259) [AF 18(600)772] AD 251670 Unclassified

Also published in Jour. Chem. Phys., v. 31: 1227-1230, Nov. 1959.

Further expressions are developed which relate the parameters of the asymmetric rotator to experimental data through moments of the energy levels. The expressions developed here apply to an asymmetric rotator system described by a Hamiltonian which includes terms allowing for 1st-order centrifugal stretching effects. A criterion for the applicability of the 1st-order theory is given. (Contractor's abstract)

1448

Ohio State U. [Research Foundation] Dept. of Physics and Astronomy, Columbus.

COMPUTATION OF RIGID ASYMMETRIC ROTATOR CONSTANTS FROM ENERGY MOMENTS, II, by P. M. Parker and L. C. Brown. [1959] [4]p. incl. tables, refs. [AF 18(600)772] Unclassified

Published in Jour. Chem. Phys., v. 30: 900-912, Apr. 1959.

Further expressions are given which relate the rotational constants of the rigid asymmetric rotator to experimental data through moments of the energy levels. These expressions remove the requirement that all energy levels for given J be known. Instead, the energy levels associated with one symmetry group of the rotational wave functions for given J are required. (Contractor's abstract)

1449

Ohio State U. [Research Foundation. Dept. of Physics and Astronomy] Columbus.

ELECTRON BANDS OF A ONE-DIMENSIONAL RANDOM ALLOY (Abstract), by J. S. Faulkner and J. Korrington. [1959] [1]p. [AF 18(600)772] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 276, Apr. 30, 1959.

Our model consists of a linear array of square wells, α and β , with 2 different well depths, equally spaced in a "random" sequence, with specified concentrations. Scattering of electrons with energy E by 1 well is characterized by a 2×2 matrix, A or B, expressing traveling waves on 1 side in terms of those on the other side. Scattering by a sequence of N wells is thus given by a product of N matrices, ABBAB... A random sequence of given concentration is represented by the average of all matrices obtained by permutations of this product. It is shown that the Nth root of this matrix is equal to the sum of our A and B matrices multiplied by energy dependent parameters that may be calculated for fixed N. Diagonalizing, an average reduced wave number k as a function of E is obtained.

1450

Ohio State U. Research Foundation. Dept. of Physics [and Astronomy] Columbus.

PARAMAGNETIC RESONANCE SPECTRA OF FREE RADICALS TRAPPED ON IRRADIATION OF CRYSTALLINE CARBOHYDRATES, by D. Williams, B. Schmidt

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and others. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)772], Quartermaster Institute for the Armed Forces under DA 19-129-QM-932, and Office of Naval Research)

Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 45: 1744-1751, Dec. 1959.

A number of carbohydrate substances were exposed to gamma radiation and their paramagnetic resonance spectra were studied. The extreme simplicity of the spectra for β -D-glucuronic acid and α -D-galacturonic acid monohydrate allows a reasonable postulation to be made as to the structure of the stable free radicals present in these uronic acids. The relative simplicity of the spectra obtained from irradiated β -maltose monohydrate, β -cellobiose, α,α -trehalose and raffinose further allows postulations to be made concerning the radicals formed on irradiation of these oligosaccharides. On the basis of this work and published data, structures of the free radicals present in irradiated 2-amino-2-deoxy- α -glucopyranose hydrochloride, erythritol, and D-threitol are postulated. (Contractor's abstract)

1451

Ohio State U. Research Foundation. [Dept. of Physics and Astronomy] Columbus.

SPECIFIC HEATS OF METALS AND ALLOYS BELOW 1°K, by C. V. Heer. Final rept. Nov. 1959, 7p. incl. illus. refs. (AFOSR-TR-59-198) (AF 49(638)254) AD 232127; PB 161461

Unclassified

The specific heat of a normal metal Na, a ferromagnetic metal Co, a ferromagnetic alloy $\text{Co}_{93}\text{Fe}_7$, an antiferromagnetic metal α -Mn, and an antiferromagnetic salt MnF_2 have been measured in the temperature region between 0.4 and 2°K. A 2-stage magnetic refrigerator isothermal enclosure for future studies between 0.03 and 0.3°K was completed at the end of the contract. (Contractor's abstract)

1452

Ohio State U. Research Foundation. Dept. of Physics and Astronomy. Columbus.

ATOMIC HEAT OF SODIUM METAL FROM 0.4 TO 2°K, by R. E. Gaumer and C. V. Heer. [1959] [3]p. incl. illus. diagrs. refs. (AFOSR-4426) (AF 49(638)-254)

Unclassified

Published in Phys. Rev., v. 118: 955-957, May 15, 1960.

The atomic heat of sodium metal was measured from 0.4 to 2°K using the magnetic refrigerator calorimeter. The experimental data is given by $C = 1.32T + 0.485 T^3$ millijoule/mol-°K. No anomaly is observed in this

temperature range. The experimental value of the electronic specific heat and the Pauli spin paramagnetism by Schumacher and Slichter are used for comparison with the electronic band theory of sodium and with those modifications introduced by electron-electron and lattice-electron interactions. (Contractor's abstract)

1453

Ohio State U. Research Foundation. Dept. of Physics and Astronomy, Columbus.

SPECIFIC HEATS ON Na, Co, AND Mn BELOW 1°K (Abstract), by R. E. Gaumer and C. V. Heer. [1959] [1]p. (AF 49(638)254)

Unclassified

Presented at 14th Calorimetry Conf., Yale U., New Haven, Conn., Sept. 10-12, 1959.

Specific heat measurements on Na, Co, and Mn metals have been extended to 0.4°K by the use of a magnetic refrigerator calorimeter. Experimental measurements were facilitated by the use of a lead thermal valve which is actuated by a superconducting niobium coil immersed in the helium bath, and which either thermally isolates or connects the sample to a reservoir at 0.3°K. Specific heat of singly distilled sodium metal is in reasonable agreement with that observed at higher temperatures by Roberts. The equation $C_v = 1.32T + 0.495T^3$ millijoule/mol-°K fits the experimental data between 0.4° and 2°K. No evidence of an anomaly was observed in this temperature region. The specific heat of high purity cobalt is in agreement with the previous measurements of Heer and Erickson down to 0.4°K ($C/R = 233(T/433)^3 + 5.7 \times 10^{-4}T + 4 \times 10^{-4}/T^2$). The $1/T^2$ term is a measure of the coupling between the cobalt nucleus and the electronic magnetic moment of the atom. Preliminary specific heat measurements on anti-ferromagnetic manganese and on a face-centered-cubic alloy of cobalt-iron are discussed with respect to the effect of structure on the coupling.

1454

Ohio State U. [Research Foundation. Dept. of Physics and Astronomy] Columbus.

EXACT TREATMENT OF THE ANTIFERROMAGNETIC GROUND STATE (Abstract), by H. L. Davis and J. Korringa. [1959] [1]p. [AF 49(638)264]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 242, Apr. 30, 1959.

For the purposes of this paper an antiferromagnet is defined by the Hamiltonian,

$$H = 2|J| \sum_{\text{(neighbors)}} \{S_j^z S_k^z + (1-\alpha)[S_j^x S_k^x + S_j^y S_k^y]\},$$

where α is an anisotropy parameter. The ground-state wave function of this Hamiltonian is obtained in terms of a linked-spin-cluster expansion, similar to Goldstone's linked-Feynman-diagram expansion, which gives, in principle, an exact solution of this magnetic many-body problem. The ground-state energy, short-range order, and long-range order are given for 1-, 2-, and 3-dimensional spin arrays and compared with the corresponding quantities calculated by variational means. A discussion is given, for both ground-state and excited state problems, of the applicability of the linked-spin-cluster method to Hamiltonians other than the 1 used here.

1455

Ohio State U. Research Foundation. Dept. of Physiological Chemistry, Columbus.

MECHANISM OF ACTION OF DEOXYRIBONUCLEASE, by W. J. Frajola. Final rept. Nov. 10, 1959, 15p. incl. illus. refs. (AFOSR-TR-59-188) (AF 18(603)125) AD 231402; PB 156105 Unclassified

Procedures are described for the examination of DNA in the electron microscope before and after treatment of the DNA with the enzyme, DNase. These procedures include a technique involving spraying the DNA solution upon freshly-cleaved mica and a technique involving the withdrawal of a monomolecular film of DNA upon a freshly-cleaved surface of mica. Either technique may be utilized for the production of long thin strands of DNA molecules. The enzymatic digestion of the DNA appears to occur in a random fashion without the production of smaller particles of uniform size or shape observable by the present techniques of electron microscopy. (Contractor's abstract)

1456

Ohio State U. [Research Foundation. Dept. of Psychology, Columbus].

SOME DESCRIPTIVE ASPECTS OF TWO-PERSON NON-ZERO-SUM GAMES, by A. Scodel, J. S. Minas and others. [1959] [6]p. incl. tables. (AFOSR-TN-59-396) (AF 49(638)317) AD 232544 Unclassified

Also published in Jour. Conflict Resolution, v. 3: 114-119, Mar. 1959.

This paper reports the initial results of a study designed to understand how people actually behave in game situations. It involved pairs of subjects in 2-person non-zero-sum game situations of a certain type (G type). G is played by 2 persons, 1 and 2. Each has 2 choices, α_1 and α_2 for player 1 and β_1 and β_2 for player 2. There are thus 4 possible outcomes; associated with each is a couple (x_i, x_j) that denotes the value of the

outcome to the players. The results suggest that persons involved in competitive play will seek to best one another rather than strive for a larger monetary gain which, in the course of the game, might allow the opponent to best him. It is suggested that perhaps this is related to a guarded behavior between people who are strangers to each other. The choice is between doing as well as or better, running the risk of doing worse. Under these conditions most subjects made the former choice, even at the sacrifice of a utility such as money.

1457

Ohio State U. [Research Foundation] Dept. of Psychology, Columbus.

INTERNAL AND EXTERNAL CONTROL AS DETERMINANTS OF DECISION MAKING UNDER CONDITIONS OF RISK, by S. Liverant and A. Scodel. [1959] [9]p. incl. tables, refs. (AFOSR-TN-59-888) (AF 49(638)-317) AD 232546 Unclassified

Also published in Psychol Repts., v. 7: 59-67, Aug. 1960

It is hypothesized that behavior in a situation involving decision making under conditions of risk is influenced by a dimension of internal-external control. Internally controlled persons (Is) are conceptualized as persons who attempt to maintain control in chance-dominated situations by a cautious and planned selection of probabilities, whereas externally controlled persons (Es) decide according to "hunches" or previous outcomes. As differentiated by a forced choice personality test, 28 Is and 26 Es engaged in a gambling situation in which each S was required to bet on the outcome of the toss of a pair of dice 30 times. On each trial S selected one of four amounts to bet on one of seven alternative outcomes with known objective probabilities. The principal differences between Is and Es were that the Is chose significantly more intermediate and significantly fewer low probability bets than the Es, significantly more Is than Es never selected an extreme high or low probability bet, the amount of money wagered on safe as against risky bets was significantly greater for Is, and there was a tendency for Is to be less variable in choice of alternatives. (Contractor's abstract)

1458

Oklahoma [State U.] Stillwater.

RECTIFICATION AND PHOTOEFFECTS IN SEMI-CONDUCTING DIAMONDS, by M. D. Bell. Thesis, Aug. 1956, 43p. incl. diagrs. refs. (AFOSR-TN-59-135) (AF 18(603)40) AD 211034 Unclassified

Two semiconducting diamonds were investigated with regard to rectification, photovoltaic, and photoconductive properties. The measurements of the rectification properties on both diamonds studied, indicate that the work function of the metal contact has very little effect

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in forming the rectifying barrier. Metals of both high and low work functions give considerable rectification and also show variations in the degree of rectification over the surface of the diamond. These results imply the existence of surface levels that are inhomogeneous because of crystal imperfections or impurity atoms near the surface. The sign of the rectification indicates that the diamonds are predominately p-type semiconductors at the surface. In the determination of the photoeffects as a function of wavelength, there are several significant observations: (1) the occurrence of photoeffects in the visible and IR, (2) the indication of 2 peaks in the photovoltage response, (3) the apparent polarization effects of light indicated by the decrease of the photovoltage and the reversal of current flow on interrupting the light, (4) the indication of 2 peaks occurring in the photoconductivity response curve, and (5) the high residual dark currents after excitation by either UV or IR light. (Contractor's abstract)

1459

Oklahoma State U., Stillwater.

MEASUREMENT OF CARRIER LIFETIMES IN SEMICONDUCTING DIAMOND, by J. H. Wayland, Jr. Thesis, Aug. 1958, 44p. incl. diagrs. refs. (AFOSR-TN-59-136) (AF 18(603)40) AD 211035 Unclassified

The general methods used in obtaining carrier lifetimes in semiconductors were used in an attempt to measure lifetimes in the type IIb semiconducting diamond. These methods do not seem to provide effective means for actual measurement of carrier lifetimes in the present study. The diffusion length experiment did not show a detectable effect. The photoelectromagnetic short-circuit current method of measuring lifetimes did not succeed because the high surface recombination rate rendered the effect practically impossible to measure. The pulse response method indicated that the decay times vary with the depth of the traps. Observations were made on the buildup and decay of the photocurrent produced by a 480-c light chopper. The conductivity lifetime was concluded to be less than 100 μ sec.

1460

Oklahoma [State U.] Stillwater.

DETERMINATION OF ENERGY LEVELS IN SEMICONDUCTING DIAMOND BY OPTICAL TRANSMISSION METHODS, by H. J. Stein. Thesis, May 1957, 44p incl. illus. diagrs. tables, refs. (AFOSR-TN-59-137) (AF 18(603)40) AD 211036 Unclassified

The optical properties of 2 semiconducting diamonds were investigated to obtain information on the nature of the imperfections responsible for the anomalous behavior of these rare diamonds. Optical absorption properties were examined from the fundamental cut-off in the UV to 13 μ . Observations of phosphorescence

were conducted to gain further knowledge of the energy levels and trapping levels in the forbidden energy gap. The UV cut-off value of 225 μ indicated that the forbidden energy gap is about 5.5 ev. The color of the phosphorescence suggests a trapping level near the center of the forbidden gap. Birefringence observations suggest that the level may be introduced by a slip condition in the diamond. Two possible mechanisms of conduction are formulated from the optical studies. One mechanism requires the Fermi level to lie on the acceptor level nearest the valence band. The activation energy corresponds with the 1.87- μ region and all other peaks occurring at longer wavelengths may be associated with excited states of the impurity atom. Another mechanism requires the Fermi level to lie about halfway between the valence band and the acceptor level. The activation energy is then associated with the 3.56- μ peak and the absorption at shorter wavelengths in the continuum may represent structure in the valence band.

1461

Oklahoma State U., Stillwater.

THE HALL EFFECT IN SEMICONDUCTING DIAMOND, by T. Young. Thesis, Aug. 1958, 40p. incl. diagrs. tables, refs. (AFOSR-TN-59-138) (AF 18(603)40) AD 211037 Unclassified

An investigation was conducted on the Hall effect in semiconducting diamonds. For comparison, the diamonds are separated into 2 classes, type I and type II. These 2 types differ in 4 qualities. Type I diamonds have an absorption band at 8 μ in the IR which is absent in type II. Type II diamonds are usually of a more mosaic character on their surface. Type I diamonds cut off in the ultraviolet at 3000A whereas Type II diamonds transmit at wavelengths as low as 2240A. Further subdivisions of type II into type IIa and IIb are made on the basis of their electrical resistivity. Although several other investigators have measured the Hall constant in type IIb diamond, this investigation was the first in which the resistivity of a diamond sample was as high as 10^5 ohm-cm. Previous investigations were made on samples whose resistivities were below 500 ohm-cm. The relatively high resistivity made some adjustments in the technique of measurements necessary, particularly in the area of contact phenomena.

1462

Oklahoma State U., Stillwater.

PHOTOCONDUCTIVITY IN SEMICONDUCTING DIAMONDS, by C. C. Johnson. Thesis, May 1958, 39p. incl. diagrs. refs. (AFOSR-TN-59-139) (AF 18(603)40) AD 211038 Unclassified

Photoconductivity in the type IIb diamond was studied as a function of intensity of illumination, spectral dis-

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distribution, electric field strength, temperature, and crystal orientation. Various aspects of the photovoltaic effect were also studied. Alternating current measurements were made to eliminate the error induced by the dark current changing from point to point. This change in the dark current is the result of shallow trapping. Ultraviolet induced photocurrent in the diamond is much greater than the photocurrent induced by visible light when corrected in terms of photocurrent/photon. The photocurrent peaks instead of giving a continuum, probably because of transition probabilities. The directional dependence of the peak in the visible region appears at the same wavelength regardless of direction of the applied electric field. The magnitude of the photocurrent does not appreciably change with direction. Spectral distribution of the photovoltaic effect in the visible region is very similar to the photoconductivity, except that the region is not as broad. An additional peak appears at approximately 0.4μ when the illuminated contact is on the blue end. The 0.4μ peak, after correction to photovoltage/photon, is the predominant peak. Evidently this peak is a surface phenomenon. The photoconductivity peaks shift toward shorter wavelengths and decrease in absolute magnitude with decreasing temperature.

1463

Oklahoma State U. Dept. of Chemistry, Stillwater.

ON THE MECHANISM OF UREASE ACTION, by G. Gorin. [1959] [3]p. incl. table. (AFOSR-TN-59-278) (AF 18(603)135) AD 212712 Unclassified

Also published in Biochim. et Biophys. Acta, v. 34: 268-270, 1959.

Experiments designed to determine if carbamate is an intermediate in the formation of NH_3 and CO_2 from urease-catalyzed hydrolysis of urea are reported. The results indicate that this is true when no buffering agents are added and the pH is about 9; results with a citrate buffer at pH 5.5 have also indicated carbamic acid as an intermediate. It is reported that Nessler's agent was used to indicate the absence of carbamate.

1464

Oklahoma State U. Dept. of Chemistry, Stillwater.

ISOLATION AND CHARACTERIZATION OF ELECTROPHORETICALLY HOMOGENEOUS UREASE, by G. Gorin, J. M. Katyal and others. Sept. 1959 [14]p. incl. diagrs. tables, refs. (Technical note no. 4) (AFOSR-TN-59-749) (AF 18(603)135) AD 226850 Unclassified

Description is given of the preparation of urease by a slight modification of Sumner's procedure of crystallization. Special ground jack beans were used as a source of the material. Urease preparations that behave

homogeneously on electrophoresis at pH 7 were obtained. The activity of the preparations was 97 Sumner unit/mg, and the sulfur content was 1.18 g/16 g of nitrogen.

1465

Oklahoma State U. Dept. of Chemistry, Stillwater.

KINETICS AND MECHANISM OF HYDROLYSIS OF AMMONIUM CARBAMATE, by G. Gorin and M. F. Butler. July 1959 [12]p. incl. diagrs. tables. (Technical note no. 3) (AFOSR TN-59-775) (AF 18(603)135) AD 227610; PB 144018 Unclassified

Ammonium carbamate is hydrolyzed in 0.1 M sodium hydroxide solution at 25° with a 1st-order specific rate constant of about 0.13 hr^{-1} . The rate is approx. inversely proportional to the pH in the range 0.05 - 0.25 M hydroxide. It is proposed that the decomposition of carbamic acid is the rate-determining step under these conditions. (Contractor's abstract)

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Oklahoma U. Dept. of Physics, Norman.

EXCITATION FUNCTION OF HELIUM 3^1P FOR ELECTRON COLLISIONS, by R. M. St. John, C. J. Bronco, and R. G. Fowler. [1959] [5]p. incl. diagrs. refs. (AFOSR-TN-59-935) (AF 49(638)41) AD 235361 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 50: 28-32, Jan. 1960.

The function for the excitation of the helium 3^1P level by electron impact has been determined optically.

Light intensity of the $3^1\text{P} - 2^1\text{S}$ transition (5016 A) was detected by a sensitive photomultiplier; its output was measured by a microammeter. The intensity of the 5016A line was proportional to electron beam current for all currents used and proportional to helium pressure for less than 3×10^{-4} mm. Above 3×10^{-4} mm pressure imprisonment of resonance radiation enhanced the light intensity. The excitation function has a peak value of $2.4 \times 10^{-18} \text{ cm}^2$; this occurs at an electron energy of 100 ev. Absolute determination of the cross section was possible through the calibration of the light detection system by a tungsten ribbon standard lamp. The experimental curve is corrected by removing cascade components from it. (Contractor's abstract)

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Oklahoma U. [Dept. of Physics] Norman.

LOW PRESSURE HELIUM EXCITATION FUNCTION

AIR FORCE SCIENTIFIC RESEARCH

(Abstract), by R. M. St. John and F. E. Fajen. [1959]
[1]p. (AFOSR-TN-59-936) [AF 49(638)41]

Unclassified

Presented at Twelfth annual Gaseous Electronics Conf.,
Washington, D. C., Oct. 14-16, 1959.

Presented at meeting of the Amer. Phys. Soc., Rice
Inst., Houston, Tex., Mar. 4-5, 1960.

Published in Bull. Amer. Phys. Soc., Series II, v. 5:
120, Mar. 4, 1960.

The excitation function for several excited states of helium have been examined for electron energies from 30 to 500 ev. The absolute value of the 3^1P function has been obtained through the use of a tungsten strip standard lamp. A sensitive photomultiplier was used for light detection. Pressures utilized in the excitation measurements were as low as 1×10^{-4} mm and absorption of resonance radiation was negligible for pressures below 3×10^{-4} mm. Filters were used for wavelength selection. When more than 1 line was transmitted, spectrographic data gave relative intensities. Levels contributing cascade components to the 3^1P level were studied and their effects eliminated. The 3^1P function of excitation by electron impact only has a peak value of $2.4 \times 10^{-18} \text{ cm}^2$ at 100 ev. (Contractor's abstract)

1468

Oklahoma U. [Dept. of Physics] Norman.

EXCITATION CROSS-SECTION MEASUREMENTS ON
HELIUM 3^1P LEVEL BY OPTICAL METHODS (Abstract), by R. M. St. John, R. G. Fowler, and C. [J.] Bronco. [1959] [1]p. [AF 49(638)41] Unclassified

Presented at meeting of the Amer. Phys. Soc., Texas
U., Austin, Mar. 6-7 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
105, Mar. 6, 1959.

Absolute measurements on cross sections for excitation of the helium atom from ground to the 3^1P level by electron impact have been made. Observations were made on 5016A radiation using a high gain photomultiplier. The photomultiplier current was measured with a microammeter for moderate light intensity levels, but with single pulse counting techniques at low levels. The light intensity from the collision chamber was measured as a function of electron beam current and helium pressure. The intensity was proportional to the current. This showed multiple collisions by a single electron were not prevalent. The intensity was proportional to pressure for pressures up to about 7×10^{-3} mm Hg. Above this pressure the intensity rose more

rapidly, indicating that resonance radiation effects were in operation. Relative intensity data by Fowler and Duffendack have been used to extend the intensity-pressure curve to pressures as high as 0.1 mm Hg.

Last, the excitation function of the 3^1P level was found with helium pressures low enough to prevent resonance radiation effects. The maximum cross section occurred for electrons of about 65- or 70-ev energy.

1469

Oklahoma U. [Dept. of Physics] Norman.

OPTICAL EXCITATION CROSS-SECTION MEASUREMENTS OF HELIUM 3^1P LEVEL (Abstract), by R. M. St. John, C. [J.] Bronco, and R. G. Fowler. [1958] [1]p. [AF 49(638)41] Unclassified

Presented at Eleventh Annual Gaseous Electronics
Conf., New York, Oct. 22-25, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
110, Mar. 6, 1959.

Absolute measurements on cross sections for excitation of atoms by electrons are being made. The helium 3^1P level is being studied by observing 5016A light from the collision chamber. Low gas pressure and small electron beam currents require the use of single-pulse counting techniques in which a high-gain photomultiplier, linear amplifier, and scaler are used. The photomultiplier is employed at liquid air temperatures to reduce dark counts. The apparent cross section for the helium 3^1P level was found to be independent of electron beam current. It showed a broad maximum whose peak occurred at an electron energy of about 120 ev. The cross section appeared to be independent of pressure for pressures as high as 10^{-2} mm Hg. Thus, secondary processes presumably were not taking place. Absolute values of the excitation cross section of the 3^1P level will be obtained when calibration of the light-measuring equipment is completed. Estimates place the peak value near 10^{-18} cm^2 .

1470

Oregon State Coll., Corvallis.

PROCEEDINGS OF THE 1959 INTERNATIONAL SYMPOSIUM ON COLOR CENTERS IN ALKALI HALIDES, Oregon State Coll., Corvallis, Sept. 8-11, 1959. [Salem] Oregon State Board of Higher Education, 1959, 39p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [CSO-680-59-14], National Science Foundation, Office of Naval Research, and Oregon State College). Unclassified

AIR FORCE SCIENTIFIC RESEARCH

This symposium grouped together for mutual study and communication many of the investigators concerned with color center phenomena. Projects reported on the production of color centers by various means including heating in alkali vapor, electrolysis, and x-ray irradiation, as well as the related subjects on photoconductivity, F-center formation, and crystal purity.

1471

Oregon U. Dept. of Chemistry, Eugene.

CHEMICAL STRUCTURE AND CHROMATOGRAPHIC ADSORBABILITY OF AROMATIC HYDROCARBONS ON ALUMINA, by L. H. Klemm, D. Reed and others. [1959] [10]p. incl. tables, refs. (AFOSR-TN-59-295) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)473 and Office of Ordnance Research under DA 04-260-ORD-176) AD 231605 Unclassified

Also published in Jour. Organic Chem., v. 24: 1468-1477, Oct. 1959.

An investigation of structural factors involved in the relative chromatographic adsorbabilities of binary mixtures of aromatic hydrocarbons on alumina was made using elution of the components with petroleum ether or petroleum ether-benzene and analysis of the effluent fractions by evaporation and m.p. determination on the residues. The Law of Inequalities—i.e., if (in adsorbability) $A > B$ and $B > C$, then $A > C$ —was found to hold. Moreover, adsorbability was found to increase with increasing (a) no. of double bonds, (b) approach to coplanarity, (c) symmetry no., (d) extent of conjugation, and (e) no. of sterically unhindered methyl or alkylene groups. In 2 alkylarene series R-Ar, the effect of R in fostering adsorbability was found to be Me (unhindered) $> Et > n > i$ -Pr, *tert*-Bu. From the fact that the adsorbability relationships are closely analogous to those found for fostering stability in *bona fide* 1:1 π -type molecular compounds in solution it is proposed that adsorption on alumina also involves π -type complexation where the "active spots" on the alumina are relatively broad electron-attracting areas on to which the electron-donating hydrocarbon substrate is held monomolecularly and preferentially (where such arrangement is sterically possible) in a planar configuration parallel to the surface. (Contractor's abstract)

1472

Oregon U. Dept. of Chemistry, Eugene.

OPTICAL RESOLUTION BY MOLECULAR COMPLEXATION CHROMATOGRAPHY, by L. H. Klemm and D. Reed. [1959] [5]p. incl. table. (AFOSR-TN-59-730) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)473 and Office of Ordnance Research under DA 04-200-ORD-176) AD 237070 Unclassified

Also published in Jour. Chromatog., v. 3: 364-368, 1960.

Partial optical resolutions of 3 racemic aromatic compounds have been achieved by chromatography on silicic acid impregnated with optically active α -(2, 4, 5, 7-tetranitro-9-fluorenylideneaminoxy) propionic acid using petroleum ether as solvent. The success of this method is ascribed to the occurrence of molecular complexation (between the widely dispersed molecules of the impregnant and the aromatic compound) on the surface of the silicic acid support. (Contractor's abstract)

1473

Oslo U. [Inst. of Chemistry] (Norway).

INVESTIGATION OF MOLECULAR STRUCTURES, by O. Hassel. June 30, 1959, 1v. incl. diagrs. tables, refs. (Technical scientific note no. 1) (AFOSR-TN-59-916) (AF 61(052)71) AD 226443; PB 143638 Unclassified

A report is given consisting of 5 investigations dealing chiefly with chemical work and x-ray crystallographic analysis of solid addition compounds. The works include OSL.01:001, Vol. II, and item nos. 1474, 1475, 1476, 1477, Vol. III. Summarily the results show the structure of 2 addition compounds having chlorine as an electron acceptor, the structure of the compound 3 quinoline- $CHCl_3$, and work on 1:1 compounds formed by oxalyl chloride (and bromide) and dioxan. Additional work is going on with iodine compounds of aromatic amines.

1474

Oslo U. Inst. of Chemistry (Norway).

CHARGE TRANSFER COMPOUNDS WITH A HALOGEN ATOM LINKED TO CARBON, HALOGEN BEING THE ELECTRON ACCEPTOR. CRYSTAL STRUCTURE OF THE COMPOUND $CHCl_3 \cdot 3$ QUINOLINE, by O. Hassel and T. Bjorvatten. [1959] [4]p. incl. diagr. (AFOSR-3642) (Bound with its AFOSR-TN-59-916; AD 226443) (AF 61(052)71) Unclassified

Also published in Acta Chem. Scand., v. 13: 1261-1262, 1959. (Title varies)

The principal features of the quinoline compound structure are given. It is reported that the primitive rhombohedral unit cell contains 1 molecule of iodoform, 3 molecules of quinoline. The findings concerning position confirm the suggestion that the iodine atoms act as electron acceptors, the nitrogens as donors. It appears likely that the electron accepting iodine atom has acquired a 10 electron system resembling that of the halogen atom directly attached to the donor atom in addition compounds formed by halogen molecules.

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1475

Oslo U. Inst. of Chemistry (Norway).

CRYSTAL STRUCTURE OF THE ADDITION COMPOUND 1,4-DIOXAN-CHLORINE, by O. Hassel and K. O. Strømme. [1959] [12]p. incl. diagrs. tables. (AFOSR-3643) (Bound with its AFOSR-TN-59-916; AD 226443) (AF 61(052)71) Unclassified

Also published in Acta Chem. Scand., v. 13: 1775-1780, 1959.

An x-ray analysis of the 1:1 compound 1,4-dioxan-chlorine carried out at temperatures between -30° and -90°C shows that the crystals are isomorphous with those of the corresponding bromine compound. The monoclinic unit cell has the dimension $a = 9.36\text{Å}$, $b = 8.83\text{Å}$, $c = 4.13\text{Å}$ and $\beta = 91.5^\circ$. The observed O-Cl and Cl-Cl distances associated with the chlorine molecule bridges are 2.67 and 2.02Å, respectively. (Contractor's abstract)

1476

Oslo U. Inst. of Chemistry (Norway).

CRYSTAL STRUCTURE OF THE ADDITION COMPOUND BENZENE-CHLORINE (1:1), by O. Hassel and K. O. Strømme. [1959] [10]p. incl. diagrs. tables. (Bound with its AFOSR-TN-59-916; AD 226443) (AF 61(052)71) Unclassified

Published in Acta Chem. Scand., v. 13: 1781-1786, 1959.

The crystal structure of an equimolecular addition compound benzene-chlorine was determined using single crystal Weissenberg technique and working at low temperatures, mainly about -90°C. The crystals are monoclinic (space group $C2/m$) and isomorphous with those of the corresponding benzene-bromine compound. Chains of alternating benzene and chlorine molecules are present in the crystal, the Cl-Cl distance is 1.99Å and the distance from one particular chlorine atom to the nearest benzene plane (3.28Å), a little shorter than the corresponding distance in the bromine compound. (Contractor's abstract)

1477

Oslo U. Inst. of Chemistry (Norway).

CRYSTAL STRUCTURE OF THE ADDITION COMPOUND 1,4-DIOXAN-SULPHURIC ACID, by O. Hassel and Chr. Rømming. [1959] [5]p. incl. diagrs. tables. (Bound with its AFOSR-TN-59-916; AD 226443) (AF 61(052)71) Unclassified

A determination of the structure of 1 compound formed by an ether and a strong inorganic acid is made by analyzing the crystal structure of the 1:1 compound 1,4-dioxan-sulphuric acid. The entire structure con-

sists of chains of alternating sulphuric and dioxan molecules. The 2 dioxan molecules linked to a particular sulphuric acid molecule by hydrogen bonds are not crystallographically equivalent but both are of the "chair" form and the directions of the hydrogen bonds are all "equatorial". The distance from the sulphur atom to the nearest "keto" oxygen atoms is 1.41Å, whereas the distance to the oxygen atoms involved in hydrogen bond formation is 1.47Å. The O-O distance of the hydrogen bridges is $2.57 \pm 0.04\text{Å}$

1478

Oslo U. Inst. of Theoretical Astrophysics (Norway).

ON THE PROPAGATION OF TRANSVERSE ELECTROMAGNETIC WAVES IN A PLASMA IN A MAGNETIC FIELD, by Ø. Holter. 1959 [56]p. incl. diagrs. refs. (Scientific rept. no. 1) (AFOSR-TN-59-1312) (AF 61(052)49) AD 232059 Unclassified

Boltzmann's equation is the basis for the most general determination of the propagation constants by statistical theory. The rather drastic simplifications necessary make the solution valid for a Lorentz gas only. By assuming a constant collision frequency the macroscopic approximation is obtained, in which a general formula for the refractive index is evaluated explicitly. The latter formula contains the Appleton-Hartree formula and Åström's results as special cases. An investigation of the collision effect on Åström-Ferraro waves gives the limiting velocity equal to zero as the frequency approaches zero. (Contractor's abstract)

1479

Oslo U. Inst. of Theoretical Astrophysics (Norway).

THEORETICAL RESEARCHES IN MAGNETO-HYDRODYNAMICS, by Ø. Holter, E. Jensen and others. Final technical rept. June 30, 1959, 19p. (AFOSR-TR-59-92) (AF 61(052)49) AD 219370; PB 145065 Unclassified

Researches were made in the general field of magneto-hydrodynamics by the Institute of Theoretical Astrophysics, Oslo. The subjects covered are plasma oscillations in the classical sense; general theory of wave propagation in a plasma; the form and importance of viscous forces in plasma phenomena when magnetic fields are active; plasma shock waves; and forces in a plasma conditioned by certain deviations from thermal equilibrium, in particular deviations from equipartition of kinetic energy.

1480

Oslo U. Neurophysiological Lab. (Norway)

FUNCTIONAL LOCALIZATION WITHIN THE AMYGDALOID COMPLEX IN THE CAT, by H. Ursin and B. R. Kaada. [1959] [23]p. incl. refs. (AFOSR-TN-59-483)

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(Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 215736
Unclassified

Also published in *Electroencephalog. and Clin. Neurophysiol.*, v. 12: 1-20, Feb. 1960.

The behavior, somatomotor and autonomic effects observed from stimulation of 182 electrode sites in the amygdala (149 in unanesthetized cats) are reported. The results, together with a closer analysis of the data published by other authors, indicate a definite topographic organization of different functions within the amygdala, although with some overlapping. Each type of response is discussed under the various sections. Behavior attention in conjunction with EEG desynchronization is related to the basolateral division of the amygdaloid complex. The responsive zone can be traced medially through the region of the central nucleus into the internal capsule. This extension appears to correspond to the c-bundle of Fox (*Jour. Compar. Neurol.*, v. 72: 1-62, 1940). Fear (flight) and anger are produced from 2 separate areas running approximately parallel within the attention zone from the basolateral nuclei and into the internal capsule and brain stem. Various somatomotor (sniffing, licking, chewing, facial contractions) and autonomic effects (salivation, respiration pupillo-dilation, micturition, defecation, piloerection) are elicited from different portions of the amygdaloid complex. The pathways for some of these reactions are briefly discussed. (Contractor's abstract)

1481

Oslo U. Neurophysiological Lab. (Norway).

THE TEMPORAL LOBE SUBSTRATE OF FEAR AND ANGER: A REVIEW OF RECENT STIMULATION AND ABLATION STUDIES IN ANIMALS AND HUMANS, by H. Ursin. [1959] 24p. incl. refs. (AFOSR-TN-59-994) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226753
Unclassified

Also published in *Acta Psychiat. et Neurol. Scand.*, v. 35: 378-396, July 1960.

A review is given of recent stimulation and ablation studies in animals and humans regarding the importance of temporal lobe structures for emotional behavior. In animals fear has been produced by stimulation of the temporal cortex and from a limited portion of the amygdala (anger from the amygdala only). The 2 types of emotional behavior patterns appear to be related to 2 separate subdivisions of the amygdaloid nuclear complex. The observations in humans, although as yet not conclusive, seem in the whole to be in agreement with the results from the animal experiments. (Contractor's abstract)

1482

Oslo U. Neurophysiological Lab. (Norway).

GENERALIZED ELECTROCORTICAL ACTIVATION BY CORTICAL STIMULATION IN THE CAT, by B. R. Kaada and N. B. Johannessen. [1959] [14]p. incl. refs. (AFOSR-TN-59-995) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226752
Unclassified

Also published in *Electroencephalog. and Clin. Neurophysiol. Jour.*, v. 12: 567-573, Aug. 1960.

The cerebral cortical areas have been determined. From electrical stimulation, a generalized electrocortical activation (desynchronization) can be elicited for these areas. Positive sites were located in: (1) the medial frontal cortex and cingulate and hippocampal gyri; (2) the intermediate lateral frontal cortex; (3) the temporo-occipital cortex; (4) the orbito-insulo-temporal polar region; and (5) the parietal cortex. The responsive areas correspond to those from which a behavior attention response, various autonomic effects, and inhibition of spontaneous movements can be obtained. Through projections to the brain stem or thalamic reticular areas, these cortical fields probably contribute to the initiation and maintenance of wakefulness and directed attention.

1483

Oslo U. Neurophysiological Lab. (Norway).

BEHAVIOR "ATTENTION" AND FEAR INDUCED BY CORTICAL STIMULATION IN THE CAT, by C. Fangel and B. R. Kaada. [1959] [29]p. incl. refs. (AFOSR-TN-59-996) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226751
Unclassified

Also published in *Electroencephalog. and Clin. Neurophysiol. Jour.*, v. 12: 575-588, Aug. 1960.

The cerebral cortical areas have been determined from which a behavior attention response can be induced by stimulation in the unanesthetized cat. Three components may be distinguished in this behavior pattern: (1) arrest of all ongoing spontaneous movement; (2) increased alertness; and (3) orienting movements towards the contralateral side. The responsive areas include: (1) the cortex of the medial frontal surface, the cingulate and hippocampal gyri; (2) the intermediate lateral frontal cortex; (3) a large temporo-occipital field; (4) the orbito-insular-temporal polar region; and (5) a weaker parietal field. These cortical zones correspond to those from which a generalized electrocortical activation have been elicited in the cat and monkey. The positive areas coincide with those previously known to produce inhibition

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of spontaneous movements, various autonomic effects and contraversion. Fear resulted from stimulation of the cingulate and temporo-occipital cortex. (Contractor's abstract)

1484

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. I. ORIGIN, COURSE AND DISTRIBUTION IN CAT, RABBIT, AND RAT, by P. Andersen. [1959] [47]p. incl. refs. (AFOSR-TN-59-997) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226758 Unclassified

Also published in Acta Physiol. Scand., v. 47: 63-90, 1959.

The 1st in a series of studies concerned with the activation of the hippocampal fields CA1 and CA3 by interhippocampal impulses is described. The evoked potential technique was employed in cats, rabbits and rats under urethane-chloralose anesthesia. The origin of the interhippocampal impulses was the point homotopic to the recording electrode. In both CA1 and CA3, the stimulus thresholds were lowest in the pyramidal cell body and their apical dendritic shaft layers. The interhippocampal impulses of CA1 and of CA3 were abolished by ventral psalterium section. The CA1 commissural response consisted of a surface positive/negative wave with a spike on the positive wave. The positive wave was recorded negative (interpreted as an excitatory postsynaptic potential) in the layer of the apical dendritic shafts which presumably is the main termination of interhippocampal impulses to CA1, confirming anatomical studies. The CA3 commissural response was a diphasic spike (fimbria fibre activity) followed by a negative wave with a spike. The negative wave, probably an excitatory postsynaptic potential, was recorded in the layer of the basal dendrites, making this the probable termination site of CA3 interhippocampal impulses. (Contractor's abstract)

1485

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. II. APICAL DENDRITIC ACTIVATION OF CA1 NEURONS, by P. Andersen. [1959] [42]p. incl. refs. (AFOSR-TN-59-998) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226757 Unclassified

Also published in Acta Physiol. Scand., v. 48: 178-208, 1960.

An analysis of the commissural response of the field CA1 of the hippocampus, a surface positive wave with

a spike followed by a negative wave, is described. The major, later part of the surface positive wave was recorded negative in the layer of apical dendritic shafts. This deep negative wave is interpreted as a summated excitatory postsynaptic potential. It seems to have a causal relationship to the production of the spike. The spike most often showed its shortest latency in the apical dendritic shaft layers, increasing in both directions along the dendritic tree. The speed of propagation along the dendritic shaft was about 0.35 m/sec. The surface negative wave is confined to the basal layers and is probably partly due to the spread of the depolarizing wave along the dendrites and partly to the activity of superficially located neurons. In the CA1 apical dendritic membrane, 2 mechanisms were found: one was responsible for the production of the deep negative wave; the other was responsible for the initiation and propagation of the spike along the dendrites. (Contractor's abstract)

1486

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. III. BASAL DENDRITIC ACTIVATION OF CA3 NEURONS, by P. Andersen. [1959] [31]p. incl. refs. (AFOSR-TN-59-999) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226756 Unclassified

Also published in Acta Physiol. Scand., v. 48: 209-230, 1960.

The commissural afferents to the hippocampal field CA3 terminate in the layer of the basal dendrites only, making selective basal dendritic activation possible. The response of CA3 in response to a symmetrical contralateral stimulation is a diphasic spike followed by a negative wave, sometimes with a superimposed spike. The diphasic spike represents interhippocampal fibre activity. The negative wave was recorded only from the CA3 basal dendritic layer. It is partly an excitatory postsynaptic potential produced in the basal dendrites by the commissural volley, partly a postsynaptic CA3 neuron discharge. The spike is a more synchronous discharge of the same neurons. The commissural volley elicits spikes more seldom in CA3 than in CA1, where apical dendritic activation is the most prominent, suggesting that a cell discharge is easier produced by apical than by basal dendritic activation. The susceptibility to anoxia is similar for the 2 fields. Strvchnine normally produces great changes in CA1 potentials, but has only minor influence on the CA3 commissural response. (Contractor's abstract)

1487

Oslo U. Neurophysiological Lab. (Norway).

TELENCEPHALIC "AROUSAL" AREAS: THEIR

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RELATION TO THE SITE OF ACTION OF PSYCHOTROPIC DRUGS, by B. R. Kaada. [1959] [10]p. incl. refs. (AFOSR-TN-59-1000) [AF 61(514)1127] AD 226755 Unclassified

Also published in First Internat'l. Cong. of Neuropsychopharmacology Symposium on Methods and Analysis of Drug-Induced Behavior in Animals, Rome (Italy), Sept. 1958, Amsterdam, Elsevier Publishing Co., 1959, p. 38-45.

Problems of functional localization within limbic structures are discussed. The pyriform cortex, parts of the amygdala, the olfactory tubercle, bed nucleus of the stria terminalis, etc. are the areas of olfaction. The areas related to autonomic activity are the anterior cingulate, the orbito-insulo-temporal polar cortex, and part of the amygdala. The hypothalamus and brain stem reticular formation are the principal sites of fear-producing and arousal activity. A probable major therapeutic site of action of tranquilizer drugs was considered to be in the telencephalic arousal areas or their reticular (inclusive thalamic reticular) counterparts or both.

1488

Oslo U. Neurophysiological Lab. (Norway).

EFFECTS OF BARBITURATES AND NITROUS OXIDE ON THE LEVEL OF 17-OH STEROIDS AND EOSINOPHILE CELLS IN CAT, by B. R. Kaada, J. Seteklev, and O. E. Skaug. [1959] [9]p. incl. refs. (AFOSR-TN-59-1001) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 226754 Unclassified

Also published in Acta Pharmacol. et Toxicol., v. 16: 87-96, 1959.

Experiments were carried out to study the effects of sodium pentobarbital, diallylbarbituric acid, and nitrous oxide on the 17-OH-steroid level and eosinophile cells in cats (to avoid stress sensibility under anesthesia, the specimens were exposed to cold for a certain period). The results support the non-specific character of an eosinopenia in cat, and can be summarized as follows: (1) Both pentobarbital and dial barbiturates produced a marked initial and temporary rise of the plasma 17-OH-steroids in cats. This increase appears to be related to and possibly dependent of the length of the initial excitatory state. During the anesthetic stage the plasma level of the 17-OH-steroids is fairly constant. (2) The plasma 17-OH-steroids varied considerably in samples taken under a few min nitrous oxide anesthesia, possibly corresponding to the varying degree of excitement in the induction stage. (3) Dial seemed to have a less blocking effect than pentobarbital on the adrenocortical response to a moderate stress (exposure to +4°C for 90 min). (4) No constant relationship was found be-

tween the plasma 17-OH-steroids and the blood eosinophiles. Eosinopenia cannot be used as a reliable index of adrenocortical function in the cat.

1489

Oslo U. Neurophysiological Lab. (Norway).

INTERHIPPOCAMPAL IMPULSES. IV. A CORRELATION OF SOME FUNCTIONAL AND STRUCTURAL PROPERTIES OF THE INTERHIPPOCAMPAL FIBRES IN CAT, RABBIT AND RAT, by P. Andersen. July 9, 1959 [23]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-1317) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1127 and Norwegian Research Council for Science and the Humanities) AD 244781 Unclassified

Also published in Acta Physiol. Scand., v. 48: 329-351, 1960

The interhippocampal fiber activity was previously found to be represented by an initial diphasic spike of the response of the field CA3 to contralateral symmetrical stimulation. Since all the interhippocampal fibers are thin (around 1μ) and myelinated, it was felt that this tract might serve as a suitable structure for a study of the properties of thin fibers within the central nervous system. A correlation was made between various functional and structural properties of these fibers. A comparison of the results obtained in cat, rabbit, and rat can be summarized as follows: (1) The conduction velocity of the interhippocampal impulse was 3.3 m/sec in cat, 5.6 m/sec in rabbit, and 7.5 m/sec in rat; it decreased with lowering the temperature; and it decreased with increasing the anoxia duration. (2) In all 3 species, the absolute and relative refractory periods were 1.2-1.3 msec and 4-5 msec, respectively. The period of latent period was 0.3 msec.

1490

Oxford U. Dept. of Biochemistry (Gt. Brit.).

[ACETATE METABOLISM IN MICROORGANISMS] Final technical rept. Feb. 1, 1957-Jan. 31, 1959. 15p. incl. diagrs. refs. (Rept. no. 825) (AFOSR-TR-59-48) (AF 61(514)1180) AD 215261 Unclassified

This research is concerned with ascertaining the various metabolic pathways whereby acetate can serve as sole carbon and energy source for the growth of microorganisms when they are restricted to an acetate diet. Preliminary findings indicate that malate can be formed from acetate by a route not involving the tricarboxylic cycle. It was surprisingly found that isocitrate is in equilibrium with succinate and glyoxylate which reacts with acetyl coenzyme A in yield malate. The role of acetyl coenzyme A in the conversion of fat to carbohydrates is investigated also. The metabolism of other C₂-compounds is also discussed. Since some micro-

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organisms do not possess isocitratase, the metabolic routes whereby glycine, glycollate, and oxalate can serve as sole carbon source and energy source for growth become very important. It is suggested that glycine can participate as a donor and recipient in C_1 -transfer reactions similar to the reported metabolism in some anaerobic bacteria. The possible pathways whereby glycollate can provide the carbon source have not yet been elucidated but that some organisms can grow on such a diet is an established fact. The oxalate studies show that phosphoglyceric acid plays a role in the biosynthesis, but this pathway is still under investigation. The metabolism of C_1 -compounds is further discussed also.

Presented at 381st meeting of the Biochemical Society, Oxford U. (Gt. Brit.), Mar. 20, 1959.

Published in Biochem. Jour., v. 72: 3P, May 1959.

Two assay methods for key enzymes of the glyoxylate cycle are discussed. The 1st, concerned with isocitratase depends on measurement of the rate of increase of optical density at 324 m μ consequent upon the formation of glyoxylic acid phenylhydrazine from glyoxylate. The principle of the latter depends on the measurement of the rate of decrease of optical density at 232 m μ consequent upon breakage of the thio-ester bond of acetyl coenzyme A in the presence of glyoxylate. Both methods demand use of spectrophotometers sensitive at high optical densities.

1491

Oxford U. Dept. of Biochemistry (Gt. Brit.)

CARBOXYDISMUTASE ACTIVITY IN FORMATE- AND OXALATE-GROWN PSEUDOMONAS OXALATICUS (STRAIN OX 1), by J. R. Quayle and D. B. Keech. [1959] [2]p. incl. diagr. (Sponsored jointly by Air Force Office of Scientific Research under AF61(514)1180 and Rockefeller Foundation) Unclassified

Published in Biochim. et Biophys. Acta, v. 31: 587-588, Feb. 1959.

Experiments on *P. oxalaticus* (OX 1) which indicate that CO_2 fixation via ribulose 1,5-diphosphate represents, at the most, a minor pathway for fixation of oxalate carbon into cell constituents are presented. *P. oxalaticus* (OX 1) growing on oxalate as sole carbon source incorporated very little carbon from $NaH^{14}CO_3$. The extracts of oxalate-grown organisms also possessed very little activity when measured for the incorporation of $NaH^{14}CO_3$. However, when the cells were placed in fresh grown medium containing formate as sole carbon source the activity rose 15 fold. The experiments show that: (1) Carboxydismutase is synthesized before growth on formate commences. This is consistent with earlier findings that a Calvin cycle of CO_2 fixation is involved during growth on this substrate. (2) This cycle cannot operate during growth on oxalate since carboxydismutase is not synthesized, and CO_2 fixation processes occur only to a minor extent under these circumstances.

1492

Oxford U. Dept. of Biochemistry (Gt. Brit.).

ASSAY METHODS FOR KEY ENZYMES OF THE GLY-OXYLATE CYCLE (Abstract), by G. H. Dixon and H. L. Kornberg. [1959] [1]p. [AF 61(514)1180] Unclassified

1493

Oxford U. Dept. of Biochemistry (Gt. Brit.).

CARBON ASSIMILATION BY PSEUDOMONAS OXALATICUS (OX 1). I. FORMATE AND CARBON DIOXIDE UTILIZATION DURING GROWTH ON FORMATE, by J. R. Quayle and D. B. Keech. [1959] [8]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1180 and Rockefeller Foundation) Unclassified

Published in Biochem. Jour., v. 72: 623-630, Aug. 1959.

The incorporation of carbon from either $[C^{14}]$ formate or $[C^{14}]$ bicarbonate by cultures of *P. oxalaticus* (OX 1) grown on formate has been studied. Isotope appeared in both the aqueous ethanol-soluble and protein fractions of the cells during 5 min incubation periods. The distribution of radioactivity within the non-volatile constituents of these fractions, after incubation for from 12 sec to 5 min, was analyzed by chromatography and radioautography. Over 80% of the radioactivity incorporated at the earliest time into the ethanol-soluble fractions was present in phosphorylated compounds, and 5% in malate, with either $[C^{14}]$ formate or $[C^{14}]$ bicarbonate. After incubation for 1 min, radioactivity also appeared in citrate, aspartate and glutamate. In 12 sec, over 80% of the radioactivity initially incorporated into phosphorylated compounds was present in 3-phosphoglyceric acid; phosphates of glucose, fructose, sedoheptulose and ribose (to a minor extent) became labeled in the later samples. The specific radioactivity of cellular material obtained from cells grown on $[C^{14}]$ formate in air was reduced 17-fold by bubbling air + carbon dioxide (95:5, v/v) through the growing culture. Thus at least 94% of the carbon incorporated must have passed through the stage of carbon dioxide or a compound in ready equilibrium with it. These results show that the organism synthesizes cell constituents from carbon dioxide by a cycle similar to that found in photosynthetic organisms and other autotrophic organisms. The necessary energy is derived from oxidation of the formate to carbon dioxide. (Contractor's abstract)

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1494

Oxford U. Dept. of Biochemistry (Gt. Brit.).

CARBON ASSIMILATION BY PSEUDOMONAS OXALATICUS (OX 1). II. FORMATE AND CARBON DIOXIDE UTILIZATION BY CELL-FREE EXTRACTS OF THE ORGANISM GROWN ON FORMATE, by J. R. Quayle and D. B. Keech. [1959] [7]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1180 and Rockefeller Foundation) Unclassified

Published in Biochem. Jour., v. 72: 631-637, Aug. 1959.

Reactions of $[C^{14}]$ formate and $[C^{14}]$ bicarbonate in cell-free extracts (prepared with a Hughes press) of *P. oxalaticus* (OX 1) grown on formate was studied. The extracts catalyze the incorporation of $[C^{14}]$ bicarbonate into 3-phosphoglycerate in the presence of either ribulose 1:5-diphosphate or ribose 5-phosphate plus adenosine triphosphate. These findings show the existence of phosphoriboisomerase, phosphoribulokinase and carboxydismutase in the extracts. 3-Phospho $[C^{14}]$ glyceric acid is also formed in the extracts from $[C^{14}]$ formate and ribulose 1:5-diphosphate. This enzymic activity is removed by centrifuging the extract and restored by recombining the particulate and supernatant fractions. Incubation under anaerobic conditions reduced the phosphoglycerate formation from $[C^{14}]$ formate to 1/3 of that observed on aerobic incubation. Addition of methylene blue restored the anaerobic incorporation to 72% of that observed under aerobic conditions. The particulate fraction of the extract oxidizes formate to carbon dioxide. These results show that the ribulose 1:5-diphosphate-dependent incorporation of $[C^{14}]$ formate in the extract is preceded by oxidation of the formate to carbon dioxide. The extracts incorporate $[C^{14}]$ bicarbonate into malate in the presence of pyruvate and reduced di- or tri-phosphopyridine nucleotide. The latter coenzyme was the more effective. $[C^{14}]$ Bicarbonate incorporation into malate and oxaloacetate in the presence of phosphopyruvate is catalyzed by the extracts. (Contractor's abstract)

1495

Oxford U. Dept. of Biochemistry (Gt. Brit.).

ASPECTS OF TERMINAL RESPIRATION IN MICRO-ORGANISMS, by H. L. Kornberg. [1959] [30]p. incl. diagrs. tables, refs. [AF 61(514)1180] Unclassified

Published in Ann. Rev. Microbiol., v. 13: 49-78, 1959.

It is the main purpose of this review to discuss some of the difficulties encountered in the study of microbial oxidative processes, to survey some of the evidence in support of the TCA cycle, and to review reactions ancil-

lary to the cycle, including the possible routes whereby microorganisms utilize as substrates compounds more highly oxidized than acetate, such as glycolate, glycine, oxalate and formate.

1496

Oxford U. Dept. of Biochemistry (Gt. Brit.).

BIOSYNTHESIS OF CELL CONSTITUENTS FROM C_2 -COMPOUNDS. PART I. FORMATION OF MALATE FROM GLYCOLATE BY PSEUDOMONAS OVALIS CHESTER, by H. L. Kornberg and A. M. Gotto. PART II. FORMATION OF GLYCERATE FROM OXALATE BY PSEUDOMONAS OXALATICUS (OX 1) GROWN IN OXALATE, by J. R. Quayle and D. B. Keech. [1959] [5]p. incl. diagrs. refs. (AFOSR-TN-59-1137) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)180 and Rockefeller Foundation) AD 232067 Unclassified

Also published in Nature, v. 183: 1791-1793; 1794-1795. June 27, 1959.

Part I: It is shown that cells grown on glycolate contain enzymes capable of forming malate from glycolate, and a possible route for the formation of cell constituents from glycolate is suggested. Although full experimental details are reported elsewhere, the observations which led to this suggested route are presented. Part II: Growing cultures of *P. oxalaticus* were incubated with oxalate- C^{14} and the entry of C^{14} into the cells was followed by chromatographic and radioautographic techniques. The isotope from oxalate enters glycine first, and then phosphoglycerate along with other metabolites, such as sugar phosphates and alanine, become labeled. Work with cell-free extracts, using in some cases C^{14} -glyoxylate and in some cases C^{14} -oxalate, produced results which indicate that the following reactions may occur in the crude extracts: (1) 2 oxalate + 2 acetyl coenzyme A - 2 oxalyl coenzyme A + 2 acetate; (2) 2 oxalyl coenzyme A + 2 $DPNH_2$ - 2 glyoxylate + 2 coenzyme A + 2 DPN; (3) 2 glyoxylate + $DPNH_2$ - glycerate + CO_2 + DPN.

The DPN represents diphosphopyridine nucleotide. The conclusion reached is that incorporation of oxalate follows a similar route to that suggested for other pseudomonads growing on glycolate. The essential difference lies in the reduction of oxalate to glyoxylate, the latter compound being the first common intermediary metabolite of these 3 growth substrates.

1497

Oxford U. Engineering Lab. (Gt. Brit.).

RADIATION AND ENERGY LOSS OF AN ELECTRON IN AN INFINITELY LONG WAVE-GUIDE FILLED WITH A

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LINEAR MEDIUM, by H. Motz and M. Nakamura. Oct. 1958 [54]p. incl. diagrs. (Technical note no. 2) (AFOSR-TN-59-43) [AF 61(514)1183] AD 209215

Unclassified

Also published in Ann. Phys., v. 7: 84-131, May 1959.

Electromagnetic fields excited by a single electron with a prescribed motion in an infinitely long cylindrical space surrounded by perfectly conducting walls, and filled with a uniform linear medium, are investigated. The medium is assumed to be lossy to avoid complexities arising from the radiation condition. A general expression is obtained for the electric Hertz vector. Electric fields are calculated from this Hertz vector for (1) uniform motion of the electron parallel to the axis of a waveguide of arbitrary cross section, (2) uniform but longitudinally oscillatory motion, and (3) undulating motion with constant velocity parallel to the axis of a rectangular waveguide. Results show that the electric field can be represented as the sum of residues corresponding to different field patterns. The power flow from the electron to the electromagnetic field is calculated. An upper limit is shown to exist for the energy loss including Cerenkov and electrostatic loss. Connected with the fact that undulator radiation is propagated both forward and backward, no upper limit can be given in the case of undulator radiation. In the limit of infinitely large cross section of the waveguide, the formulae tend to the results for the unbounded medium.

1498

Oxford U. Engineering Lab. (Gt. Brit.).

A NON-THERMAL DIRECT-CURRENT PLASMA-HEATING MECHANISM, by D. Reagan. [1959] [1]p. (AFOSR-TN-59-198) [AF 61(514)1183] AD 211475
Unclassified

Also published in Nature, v. 183: 102, Jan. 10, 1959.

The coupling of the E_z component of the applied dc electric field and an electron to generate traveling compressional waves in a plasma has been investigated. The ion relaxation principle suggested by Schlüter has been used to show that if the electron moves undisturbed through a complete vibratory cycle in its magnetic potential well, it will divert all the energy it has gained from E_z in the interval to the magnetic field.

It is possible that such oscillations contribute to the remarkably fast ion heating in recent experiments.

1499

Oxford U. Engineering Lab. (Gt. Brit.).

FAST ION HEATING, by D. Reagan. [1959] [2]p. (AFOSR-TN-59-893) [AF 61(514)1183] AD 225320
Unclassified

Also published in Phys. Rev. Lett., v. 2: 92-93, Feb. 1, 1959.

Transverse magnetic compression waves are invoked to account for part of the ion heating which occurs in "Zeta" and "Sceptre". An estimate is quoted of the magnitude of the energy available due to modes excited by the initial collapse of the discharge. The time required to give 100 ev energy to the ions is approximately 0.1 msec.

1500

Oxford U. [Engineering Lab.] (Gt. Brit.).

SOME COMPRESSION WAVES IN PLASMAS, by D. Reagan. [1959] [1]p. incl. table. (AFOSR-TN-59-899) [AF 61(514)1183] AD 225319
Unclassified

Also published in Phys. Fluids, v. 2: 93, Jan.-Feb. 1959.

Experiments are described on the excitation of compression waves in plasmas by transient phenomena such as shocks and arcs, or by hydromagnetic instabilities. The possibility of powering them from an external source is suggested.

1501

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

PRODUCTION OF HIGH CONCENTRATIONS OF HYDROGEN ATOMS, by K. R. Jennings and J. W. Linnett. [1959] [2]p. (AFOSR-TN-59-227) (AF 61(514)1117) AD 211810
Unclassified

Also published in Nature, v. 192: 597-598, Aug. 30, 1958.

A detailed description of hydrogen atom production using 9.7 mc/s radiation from a 350 w radiofrequency oscillator is presented. The resulting atomic concentration of 50-60%, 25 cm downstream from the discharge compares favorably with other methods of high concentration hydrogen production.

1502

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

THE RECOMBINATION OF OXYGEN ATOMS AT SURFACES, by J. C. Creaves and J. W. Linnett. [1959] [8]p. incl. diagrs. tables. (AFOSR-TN-59-228) [AF 61(514)1117] AD 211841
Unclassified

Also published in Trans. Faraday Soc., v. 54: 1323-1330, Sept. 1958.

Linnett and Marsden's apparatus, with some modifications, was used for determining the accommodation

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coefficients for the removal of oxygen atoms at surfaces. The results at room temperature for 28 surfaces (elements, oxides and halides) are presented and discussed. The conclusions may be summarized as follows: (1) For most of the surfaces the decay of atom concentration down the side tube is, within our experimental error, exponential, showing that the wall removal-process is usually 1st order. In the few cases where the decay appears not to be strictly exponential the surface may not be uniform; (2) The range of values for the recombination coefficient is from 10^{-4} to 2×10^{-1} ; and (3) The activity cannot be related to any single parameter associated with the surface material though some of the comparisons can be understood on the basis of a particular mechanism. (Contractor's abstract)

1503

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

PRODUCTION OF ATOMS USING ELECTRIC DISCHARGES, by J. C. Greaves, K. R. Jennings, and J. W. Linnett. Feb. 1959, 18p. (AFOSR-TN-59-293) (AF 61(514)1117) AD 213033 Unclassified

Experiences in the production of atoms by electric discharges are reported. Initially, discharges between internal metal electrodes were used. This method was later discarded in favor of electrodeless discharges, with radiation of frequencies near both 10 and 3000 mc used to maintain discharge. Results indicate that an arrangement using an RF transmitter is preferred to microwave radiation for maintaining discharge, and that by this method concentrations of atomic hydrogen greater than 50% at pressure of 1/10 mm can be produced. However, for pressure greater than 10 mm the theory is advanced that microwave radiation might prove superior to RF for producing the discharge. (ASTIA abstract)

1504

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

A STUDY OF DIFFUSION IN A REACTING SYSTEM, by P. G. Dickens, D. Schofield, and J. Walsh. Feb. 1960 [17]p. Incl. diagrs. table, refs. (AFOSR-TN-59-868) (AF 61(514)1117) AD 236533; PB 147106 Unclassified

Also published in Trans. Faraday Soc., v. 56: 225-233, Feb. 1960. (Title varies)

An effort was made to derive and solve numerically the 3-dimensional, non-linear diffusion equation for the recombination of atoms at surfaces. The following conclusions were made: (1) The simple exponential relationship $\epsilon = \epsilon_0 \exp(-2/\delta)^{1/2} z/R$ is an adequate theoretical expression for the measurement of δ for surfaces of low activity if atom concentrations of less than 10% are used. (2) If higher atom concentrations are used, solutions of the non-linear, 1-dimensional equation are the best approximations for inactive surfaces. (3) If probes are used for the measurement of atom concentrations and approximated geometrically to the end plate model, the slope of the graph of $\ln(\epsilon/\epsilon_0)$ against L/R for large L/R is independent of the probe activity and is $-(2/\delta)^{1/2}$. Quantitatively, for all but the most active surfaces, values of L/R can be used for which ϵ/ϵ_0 has fallen to 0.1. Alternatively, for low initial atom concentrations, the procedure adopted by Wise and Ablow (Jour. Chem. Phys., v. 28: 634, 1958) can be used. (4) For conditions of high atom concentrations and active walls, the correct solutions of the diffusion problem cannot adequately be approximated by the solutions of the simpler equations.

1505

Oxford U. Inorganic Chemistry Lab. (Gt. Brit.).

RECOMBINATION OF ATOMS AT SURFACES. PART 7. HYDROGEN ATOMS AT SILICA AND OTHER SIMILAR SURFACES, by M. Green, K. R. Jennings and others. Feb. 1960 [27]p. Incl. diagrs. refs. (AFOSR-TN-59-869) (AF 61(514)1117) AD 236829; PB 147499 Unclassified

Also published in Trans. Faraday Soc., v. 55: 2152-2161, Dec. 1959.

The recombination coefficients for H at SiO_2 , B_2O_3 , Al_2O_3 , K_2HPO_4 , and K_3PO_4 surfaces were measured from 20° to 600°C. The effect of washing and treating the SiO_2 surface in different ways was examined. A reasonable explanation was offered for the wide range of results with temperature by assuming that the surface hydroxyls are inactive, whereas saturated O atoms in the surface are active sites. The mechanism assumed was the loose attachment of an H atom followed by its removal by another one.



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1506

Palermo U. Inst. of Physics (Italy).

RESEARCH ON CRYSTAL PLASTICITY, by D. A. Aboav. Final rept. Jan. 1959, 24p. incl. diags. tables, refs. (AFOSR-TR-59-27) (AF 61(514)1078) AD 212257; PB 142098 Unclassified

A theory is advanced to describe plastic deformation of metal crystals, particularly laminar glide in hexagonal crystals. It is assumed that the internal energy of a crystal is not uniformly distributed among the elements of its lattice, but develops a definite configuration, i.e., the "secondary structure" of the crystal. To define this configuration, an additional parameter, the "state" of a lattice-element is introduced and the energy of a pair of neighboring lattice elements is assumed to contain a term proportional to the difference of their states. Temperature and entropy are defined in terms of exchanges of state between neighboring elements. An attempt is made to relate the critical shear stress, the hardening that accompanies laminar glide, and crystal recovery to changes in the secondary structure. Within a certain range of purity, the critical shear stress of a crystal increases as the cube root of the concentration of impurity, but below a critical concentration, it is independent of impurity content. By employing the secondary structure theory, the indentation hardness, H , of many pure metals is given as $H = 1/20G/n$, where G is the shear modulus of elasticity and n is the number of glide directions. The scratch hardness is independent of n and roughly proportional to the square root of G . Metal fatigue is attributed to a universal property of crystalline matter; the inability of a metal to withstand as great a stress under cyclic stressing as under static load arises from a slow irreversible change in the secondary structure.

Palmer Physical Lab., Princeton, N. J. *see* Princeton U. Palmer Physical Lab., N. J.

Palomar Observatory, Pasadena, Calif. *see* California Inst. of Tech. Palomar Observatory, Pasadena.

1507

Paris U. (France).

INTERNAL DOUBLE REFLECTION IN A PERFECT CRYSTAL, by A. Guinier and E. Guyon. Nov. 15, 1958 [18]p. incl. illus. diags. refs. (Scientific note no. 1) (AFOSR-TN-59-124) (AF 61(052)51) AD 210429 Unclassified

Also published in Jour. Appl. Phys., v. 30: 622-628, May 1959.

Double Bragg reflections can occur in perfect single crystals. Streaks are visible starting from the trace

of the direct beam towards the primary Bragg spots. The geometry of the observed streaks is explained. Thin intensity cannot be accounted for by the dynamical theory. An attempt to use the kinematic theory has been made and leads to results which are in qualitative agreement with experiments. Examples of this kind of internal double Bragg-reflections are given for LiF, diamond and an alloy Al-Cu. (Contractor's abstract)

1508

Paris U. (France).

STUDIES OF DISLOCATIONS IN METALS BY X-RAY METHODS, by A. Guinier. Annual summary rept. no. 1, Jan. 1, 1958-Jan. 1, 1959, 9p. incl. diags. refs. (AFOSR-TN-59-348) (AF 61(052)51) AD 213868; PB 144519 Unclassified

The atomic structure of a dislocation was studied by means of diffuse x-ray scattering. Suitable specimens were obtained with single Cu crystals so that only one system of slip lines would be visible. Theoretical calculations showed that scattering is concentrated in the immediate vicinity of the normal nodes of the reciprocal lattice. The scattering due to the thermal agitation is also maximum around the nodes, and its intensity is larger than the expected scattering from the dislocations even at low temperatures. Localization of the imperfections or dislocations in a crystal was investigated by x-ray techniques. Two extreme theoretical cases which were studied are the perfect crystal with dynamical theory and the mosaic crystal with the cinemematical theory. The predicted reflecting power is much smaller for the perfect crystal. (ASTIA abstract)

1509

Paris U. (France).

SMALL ANGLE SCATTERING MEETING. SUMMARIZING REMARKS, by A. Guinier. [1959] 6p. [AF 61(052)-51] Unclassified

Presented at Small X-Ray Conf., Kansas City, Mo., Sept. 23-25, 1958.

Published in Jour. Appl. Phys., v. 30: 601-603, May 1959.

The summarizing remarks to the Small Angle X-Ray Conf. are presented. Some basic facts about small angle scattering techniques are reviewed as well as the various breakthroughs and new discoveries.

1510

Paris U. Lab. de Physique (France).

ON THE CONNECTION BETWEEN THE S-MATRIX AND A CLASS OF NON-LOCAL INTERACTIONS, by

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Kh. Chadan. [1958] 23p. incl. diagrs. refs. (Technical note no. 11) (AFOSR-TN-59-49) (AF 61(514)1060) AD 209420 Unclassified

Also published in Nuovo Cimento, Series X, v. 10: 892-908, Dec. 1958.

The method of Gourdin and Martin (Nuovo Cimento v. 6: 757, 1957; v. 8: 699, 1958) for finding a phenomenological separable interaction from the S-matrix which gives exact and explicit formulas relating the interaction to the phase-shift and bound state binding energy is generalized to the case where the interaction is the superposition of a non-local separable interaction and a local one, both of them being central. The local part of the interaction is assumed to be known and the separable part can be determined by the S-matrix. The methods and results are analogous to those of Gourdin and Martin, except for a few modifications. Given the local part of the interaction, the phase-shift and the bound states binding energies, the separable part of the interaction can be determined if the phase-shift has a good behavior.

1511

Paris U. Lab. de Physique (France).

[THEORETICAL STUDIES OF NUCLEON-NUCLEON INTERACTIONS] Technical rept. Oct. 1, 1956-Sept. 30, 1958, 1v. incl. tables, refs. (AFOSR-TN-59-224) (AF 61(514)1060) AD 211606; PB 150693

Unclassified

A summary of the accomplishments and a review of the present situation of the theory of nuclear and anti-nuclear forces is presented. The reported results of this work (PAR.01:001-007, Vol. II; and item no. 1510, Vol. III) show the following: (1) Theoretical evidence has been given for a long range imaginary force between nucleon and antinucleon and a mathematical method to calculate it has been produced; (2) A phenomenological analysis of the experimental data has shown that the real potential is likely to explain the results; (3) Progresses have been made in the study of the origin of spin-orbit coupling in nuclei; (4) The problem of deducing a non-local separable interaction from the collision matrix has been completely elucidated and exact solutions have been given; and (5) A powerful method has been given to treat high energy nucleon-nucleon scattering.

1512

Paris U. Lab. de Physique Théorique et Hautes Energies (France).

K^+ -DEUTERIUM SCATTERING-I, by M. Gourdin and A. Martin. [1959] 15p. incl. diagrs. (Technical note no. 12) (AFOSR-TN-59-48) (AF 61(052)173) AD 209419; PB 139557

Unclassified

Also published in Nuovo Cimento, Series X, v. 11: 670-678, Mar. 1, 1959.

Theoretical K^+ -deuteron scattering, both elastic and inelastic, was studied. Impulse approximation was used for the calculation neglecting final state interactions and P-waves. The sensitivity of the results to the $I = 0$ scattering length was investigated. Results show that the exchange cross section permits conclusions to be drawn on the $I = 0$ elementary scattering amplitude. This preliminary work is unsatisfactory because elementary P amplitudes which are present in the high energy domain were not introduced. Consideration should be given to the interaction of the 2 nucleons in the final state which might enhance the cross sections by an appreciable factor.

1513

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

ON THE DESCRIPTION OF UNSTABLE PARTICLES IN QUANTUM FIELD THEORY, by M. Levy. [1959] 36p. incl. diagrs. refs. (Technical note no. 13) (AFOSR-TN-59-417) (AF 61(052)173) AD 214564; PB 142097

Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 115-143, July 1, 1959.

The mass and lifetime of an unstable particle may be defined by the real and imaginary parts of a complex pole appearing on the Riemann surface in which its propagator can be continued analytically. This method, which was originally proposed by Peleris, is studied in detail, first on the basis of a special model, then in a more general field theory. The possibility of analytical continuation of the propagator is discussed, using the conditions of causality and unitarity of the S-matrix. The appearance of unphysical poles in the various sheets of the Riemann surface is also discussed. It is inferred that a physical principle must be used in each case, in order to select the particular pole which can be correctly interpreted as describing the properties of an unstable particle. (Contractor's abstract)

1514

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

ON THE VALIDITY OF THE EXPONENTIAL LAW FOR THE DECAY OF AN UNSTABLE PARTICLE, by M. Lévy. [1959] [13]p. incl. diagrs. refs. [Technical note no. 15] [AF 61(052)173]

Unclassified

Published in Nuovo Cimento, Series X, v. 14: 612-624, Nov. 1, 1959.

The departure from the exponential decay law of an unstable particle is discussed, with the help of the Lee

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model, starting from an initial state which is a general superposition of eigenstates of the Hamiltonian. It is shown that the asymptotic behavior and the magnitude of the additional terms are strongly affected by the production mechanism; although they can never vanish exactly, these terms can be made arbitrarily small by an appropriate preparation of the initial state. A possible generalization of this result is discussed. (Contractor's abstract)

1515

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

K⁺-DEUTERIUM INELASTIC AND EXCHANGE SCATTERING.-II, by M. Gourdin and A. Martin. [1959] [13]p. incl. diagrs. refs. [Technical note no. 14] [AF 61(052)-173] Unclassified

Published in Nuovo Cimento, Series X, v. 14: 722-734, Nov. 16, 1959.

The importance of the K⁺-deuteron scattering in the study of the K⁺-nucleon interaction has led to an improved calculation. The final state interaction of the nucleons when the deuteron is split during the collision is taken into account. The other approximations made previously (impulse approximation, constancy of the elementary scattering amplitudes) are maintained. The total cross-sections suffer then relatively small modifications, whereas the differential cross-sections are very sensitive to the final state interaction. The numerical calculations were made on an IBM 704 computer. The angular distributions and the total scattering cross-sections are given. The latter, as well as the ratio of the exchange scattering to the non exchange scattering, appear to be the simplest means of obtaining information on the scattering amplitude of the I = 0 isospin state of the K⁺ meson-nucleon system. (Contractor's abstract)

1516

Paris U. [Lab. de Physique Théorique et Hautes Energies] (France).

RELATIVISTIC DEUTERON WAVE FUNCTION.-I, by M. Gourdin and J. T. T. Van. [1959] [14]p. incl. diagrs. refs. [Technical note no. 16] [AF 61(052)173] Unclassified

Published in Nuovo Cimento, Series X, 1051-1064, Dec. 1, 1959.

The deuteron problem is studied starting from the relativistic wave equation of Bethe and Salpeter. It is possible, after certain approximations, to calculate the coupling constant corresponding to the binding energy measured experimentally and to give an explicit numerical form for the wave function in the energy momentum space. A Fourier transform of this wave function taken at the limit of equal times is compared with the Hulthén

non-relativistic wave function usually used to represent the deuteron. The relativistic corrections produce a repulsive effect analogous to a hard core, and this result is in agreement with the one already found in the nucleon-nucleon scattering problem which was previously worked up. (Contractor's abstract)

1517

Pennsylvania State U. [Dept. of Aeronautical Engineering] University Park.

GASDYNAMICS OF PLASMAS (Abstract), by H. Li. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) [AF 49(638)647] Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

A theoretical investigation of the gasdynamics of plasmas has been initiated to study the macroscopic equations of magnetogasdynamics and the expressions for the transport properties (electrical and thermal conductivities, viscosity and diffusion). The hydrodynamic equations (continuity, momentum and energy) will be derived for a gaseous mixture of neutral and charged particles in the presence of an electromagnetic field. This derivation of the equations will be based upon the kinetic theory of gases. At 1st, the effects of the chemical reaction (dissociation and ionization) will be neglected, but later the hydrodynamic equations will be modified for a chemically reacting gaseous mixture with internal degree of freedom. Similarly, a preliminary evaluation of the transport coefficients will be made. This evaluation will be based on a 2nd approximation of the velocity distribution function for a fully ionized gas. Two different models of the particles will be considered. The particles will be taken as rigid elastic spheres in the 1st model and as centers of force in the 2nd.

1518

Pennsylvania State U. Dept. of Chemistry, University Park.

STEREOSPECIFIC TRANS RADICAL ADDITION OF DBr TO THE 2-BUTENES SYNTHESIS OF ERYTHRO- AND THREO-3-DEUTERO-2-BROMOBUTANES, by P. S. Skell and R. G. Allen. [1959] 13p. (AFOSR-TN-59-388) (AF 49(638)457) AD 214508; PB 142682 Unclassified

Presented at meeting of the Div. of Org. Chem. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 134th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 27-P. (Title varies)

Also published in Jour. Amer. Chem. Soc., v. 81: 5383-5385, Oct. 20, 1959.

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Pure erythro- and threo-3-deutero-2-bromobutanes can be synthesized by radical chain additions of deuterium bromide to trans and cis-2-butenes, respectively. Structures and purity were determined by alkaline dehydrohalogenation, erythro- yielding trans-2-butene and cis-2-deutero-2-butene, threo- yielding cis-2-butene and trans-2-deutero-2-butene. The mechanistic implications are considered. (Contractor's abstract)

1519

Pennsylvania State U. Dept. of Chemistry, University Park.

SPECIFIC ROTATIONS OF PURE 2-BROMOBUTANES. STEREOCHEMISTRY OF THE 2-BUTANOL TO 2-BROMOBUTANE CONVERSION, by P. S. Skell, R. G. Allen, and G. K. Helmkamp. May 31, 1959, 18p. incl. diagrs. tables, refs. (AFOSR-TN-59-544) (AF 49(638)-457) AD 216560; PB 142020 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 410-414, Jan. 20, 1960.

There is no satisfactory method for demonstrating the optical purity or for resolving alkyl halides with halogen at the asymmetric center. The purest 2-bromobutane reported in the literature ($[\alpha]_D^{25}$ 28.6°) is now demonstrated to be 28% racemized. Introduction of 1 deuterium in the 3-position creates a 2nd asymmetric center which serves as an internal standard of configuration, enabling one to define the stereochemical course of reactions without resorting to resolutions. Erythro- and threo-3-deutero-2-butanols are converted to the bromides with phosphorous tribromide. Comparison of these products with pure erythro- and threo-3-deutero-2-bromobutanes indicates the alcohol to bromide conversion occurs without skeletal rearrangement and produces a product which is 85-90% inverted at the carbinol carbon corresponding to 20-30% racemization. The remainder has the same configuration as the alcohol. Thus it becomes possible to estimate $[\alpha]_D^{25}$ for optically pure 2-bromobutane (39.4°), erythro-3-deutero-2-bromobutane (38.9°) and threo-3-deutero-2-bromobutane (39.9°). Racemization is minimized by low reaction temperatures, 2-bromobutane with $[\alpha]_D^{25}$ + 32.09° being produced at -15°. (Contractor's abstract)

1520

Pennsylvania State U. Field Emission Lab., University Park.

A SEARCH FOR POLARIZATION OF FIELD-EMITTED ELECTRONS, by W. T. Pimbley. June 1959, 53p. incl. illus. diagrs. table, refs. (Technical rept. no. 10) (AFOSR-TN-59-622) (AF 18(600)672) AD 217686; PB 143174 Unclassified

Experiments were performed designed to detect polarization of field-emitted electrons using Mott scattering. Electrons emitted from various crystallographic planes of a clean tungsten surface, from individual quarters of a phthalocyanine quadruplet on a clean tungsten substrate and from single ferromagnetic domains of iron were analyzed in a temperature range from 21°K to 900°K. In no case was any polarization detected. The average least detectable asymmetry factor that could be determined by the apparatus was calculated to be .04 corresponding to a polarization of 10% in a plane normal to the field emitted beam. (Contractor's abstract)

1521

Pennsylvania State U. Field Emission Lab., University Park.

EXPERIMENTAL MEASUREMENT OF THE TOTAL-ENERGY DISTRIBUTION OF FIELD-EMITTED ELECTRONS, by R. D. Young and E. W. Müller. [1959] [6]p. incl. diagrs. (AFOSR-3506) (AF 18(600)672) Unclassified

Published in Phys. Rev., v. 113: 115-120, Jan. 1, 1959.

Measurements of the energy distribution of field-emitted electrons with an improved retarding-potential analyzer revealed an unexpectedly narrow distribution width. Further study indicated that the tube measures the distribution in total energy of field-emitted electrons. Experimental distributions as narrow as 0.14 ev were measured. Data were obtained at liquid hydrogen, liquid nitrogen, and room temperatures and were found to be in good agreement with the new theory. The resolution of the improved analyzer is estimated to be between 0.02 and 0.03 ev. The experimental results obtained from the very sensitive total-energy distribution measurements serve as a further verification of the Fowler-Nordheim theory in the total-energy representation. (Contractor's abstract)

1522

Pennsylvania State U. Field Emission Lab., University Park.

[THE RESOLUTION CAPACITY OF THE FIELD ION MICROSCOPE] Das Auflösungsvermögen des Feldionenmikroskopes, by E. W. Müller. [1956] [9]p. incl. illus. diagrs. refs. (AFOSR-3507) (AF 18(600)672) Unclassified

Also published in Zeitschr. Naturforsch., v. 11a: 88-94, 1956.

A consideration of the resolution of a field emission microscope appears to be advantageous with ions rather than electrons. Some data on field desorption and field emission is conveyed and the mechanism of this effect is explained. From this, there follows a relationship

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for the resolution, which is confirmed experimentally. Helium proves to be quite favorable for the representation of very strong metal surfaces. Cooling of the microscope with solid nitrogen or liquid hydrogen to increase the accommodation coefficient helps keep the atomic structure of the object visible. Adjacent tungsten atoms of 2.74 Å distance are clearly separated.

1523

Pennsylvania State U. [Field Emission Lab.] University Park.

PERFECTION OF METAL CRYSTAL SURFACES BY FIELD EVAPORATION (Abstract), by E. W. Müller. [1959] [1]p. [AF 49(638)504] Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 322-323, June 18, 1959.

The habit of a field evaporated metal crystal is a result of the condition that the field, determined by applied voltage and surface geometry, removes ions from all surface elements at the same rate. For a high-purity crystal a rounded off shape is expected with the local radius of curvature varying in the same sense as the work function of the considered region. A perfect surface with high index net planes can only be developed with high purity materials. If in a cubic lattice the highest Miller index of an appearing plane is h , the concentration of impurities must be less than $1/h^3$, and the minimum tip radius which will allow the development of such a plane is approximately h^3 times the half lattice constant. Experimental examples are shown of pure crystals of the platinum metals exhibiting more than 1000 facet-like net planes with Miller indices up to 11, and of similar tungsten crystals and iron whiskers. Impure crystals and alloys assume an irregular surface because of local randomness of work function and work to field evaporate an ion.

1524

Pennsylvania State U. [Field Emission Lab.] University Park.

FIELD ION MICROSCOPE STUDIES OF SURFACE CORROSION, OF INTERSTITIALS, VACANCIES AND α -IRRADIATION DAMAGE BY CONTROLLED FIELD EVAPORATION OF ATOMIC LAYERS, by E. W. Müller. [1959] [14]p. incl. illus. refs. (Bound with its AFOSR-TR-59-212) [AF 49(638)504] Unclassified

Also published in Proc. Internat'l. Conf. on Structure and Properties of Thin Films, Bolton Landing, N. Y. (Sept. 9-11, 1959), New York, Wiley and Sons, 1959, p. 476-489.

A study is reported on the use of the field evaporation technique at low temperatures operated with helium ions. Corrosion was accomplished by turning the field off and applying it again after oxygen had come in contact with the surface. The perfect surface was re-established by gradual field evaporation. It was found that the corrosion level could extend as deep as 5 layers in the case of tungsten. Platinum oxidation is slower. Adsorbed hydrogen atoms, it is believed, block the adsorption sites of oxygen and completely prevent the corrosion. Oxygen atoms were found in interstitial positions in the study of rhodium tips. A systematic search of the interior of the platinum tip was conducted in order to locate vacancies. Several were found corresponding to a concentration of 5.9×10^{-4} .

1525

Pennsylvania State U. [Field Emission Lab.] University Park.

[OBSERVATION OF NEARLY PERFECT METAL CRYSTALS AND POINT DEFECTS IN THE FIELD ION MICROSCOPE] Beobachtung von nahezu fehlerfreien Metallkristallen und von Punktdéfekten im Feldionen-mikroskop, by E. W. Müller. [1959] [12]p. [AF 49(638)504] Unclassified

Published in Zeitschr. Phys., v. 156: 399-410, 1959.

The perfection of the surface of field-evaporated metallic crystals in low-temperature field ion microscope depends only on the perfection and purity of the inside of the crystal. With this, a plane surface with a high Miller index h can be perfected, the concentration of disordered impurities must be smaller than h^{-3} . Surfaces evaporated crystals from highly pure Pt and W as well as ordinary Re, Pd and Ni are shown. Statistically divided flaws in the form of a Rhodium crystal are explained as oxygen atoms in interstitial spaces. In platinum, empty lattice spaces are produced by burning and quenching, and appear detached. From their directly observed concentration and quenching temperature, an energy of formation of 1.15 eV is produced.

1526

Pennsylvania State U. Groth Inst., University Park.

A PROGRAM FOR PREPARATION OF A MODERNIZED VERSION OF GROTH'S CHEMISCHE KRISTALLOGRAPHIE (Abstract), by R. Pepinsky. [1958] 3p. (AF 49(638)416) Unclassified

Presented at meeting of the X-Ray Analysis Groups, Sheffield (Gt. Brit.), Oct. 15, 1958.

A procedure has been introduced for the recording and storage of data in crystal chemistry and physics, which permits its transfer to IBM BCD magnetic tape

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in a form most efficient for IBM 704 machine input for a wide variety of crystallographic computations, and for printout by IBM 407 tabulators or cardtype machines, according to any desired categories, and directly onto reproducing (Multilith) mats. Efficient data-abstracting procedures for punched-card primary input, and methods of proof-reading and editing, have been developed. Using these new techniques, a program is in progress to record all crystal data, to compare and evaluate results from various types of measurements, and to carry out automatically all feasible crystallographic computations — including those bearing on morphology, structure analyses and their results, crystal physics, etc.

crystals on IBM punched cards. These will be further processed for extraction of specific information or special computations. The planning of the format for data requires great care at the initial stages of development, since efficiency of operation depends on it. For data processing, the IBM 704 machine will generally be used. This requires that for efficient transfer to BCD tape the data appear within 8-digit fields, properly located on the card. The present report describes abstracting procedures, and justifies these in terms of methods of data-handling and processing. It also includes some volume and time estimates, and suggests a schedule for steps in preparation of the encyclopedia. (Contractor's abstract)

1527

Pennsylvania State U. Groth Inst., University Park.

CONCERNING ESTABLISHMENT OF THE GROTH INSTITUTE AND REVISION OF GROTH'S CHEMISCHE KRYSTALLOGRAPHIE, by R. Pepinsky. Apr. 2, 1958, 26p. (Rept. no. 2) (AFOSR-TN-59-312) (AF 49(638)-416) AD 221900 Unclassified

The Groth Inst. has recently been established at Pennsylvania State U. to serve as data collecting, interpretation, and editorial center for revision of Paul von Groth's Chemische Krystallographie (an encyclopedia of chemical and physical properties of crystals, published during the early 1900's). The revision is to include bringing the chemical and physical data on all crystalline solids up to date, adding information on crystals measured since the 1st edition, correlating all of this information with knowledge of internal structure as revealed by diffraction methods and other techniques, and correlating other physical and chemical properties with one another. Ultimately all of the information and interpretations on crystal data will be published in a series of volumes entitled Groth's Encyclopedia of Chemical and Physical Crystallography, Revised Edition. This program is rendered manageable through the introduction of new methods of data storage, handling and processing, involving punched card and magnetic tape storage suitable for introduction of data into high-speed large-scale computers (IBM 704), followed by automatic print-out of results on high-speed tabulators and card-to-typewriter devices.

1528

Pennsylvania State U. Groth Inst., University Park.

PRELIMINARY MEMORANDUM CONCERNING ABSTRACTING AND PROCESSING OF DATA FOR GROTH'S ENCYCLOPEDIA OF CHEMICAL AND PHYSICAL CRYSTALLOGRAPHY, REVISED EDITION, by R. Pepinsky and V. Vand. Mar. 17, 1958 [30]p. incl. diagrs. tables. (Rept. no. 3) (AFOSR-TN-59-313) (AF 49(638)316) AD 228903 Unclassified

It is planned to put all the available information on

1529

Pennsylvania State U. Groth Inst., University Park.

LIST OF DEFINITIONS OF ABBREVIATIONS FOR PERIODICALS, by R. Pepinsky and V. Vand. Apr. 21, 1958 [21]p. (Rept. no. 4) (AFOSR-TN-59-314) (AF 49(638)416) AD 228904 Unclassified

A list of definitions of abbreviations for periodicals has been prepared to help abstractors of crystallographic data at the Groth Inst. in coding the primary reference field. The list is compiled on IBM cards and is reproduced from time to time as new journal abbreviations are devised by the abstractors.

1530

Pennsylvania State U. Groth Inst., University Park.

ILLUSTRATIONS OF NEW PHOTOELECTRIC GONIOMETER FOR AUTOMATIC RECORDING OF CRYSTAL MORPHOLOGY IN THE FORM OF STEREOGRAPHIC PROJECTIONS, by R. Pepinsky, K. Dranck, and H. Diamant. Apr. 5, 1958 [19]p. incl. illus. diagrs. (Rept. no. 5) (AFOSR-TN-59-315) (AF 49(638)416) AD 228905 Unclassified

The optical goniometer is described and illustrated. The machine utilizes a standard electric bulb source, and a 931A photomultiplier as signal detector, in a well-designed optical system. The photomultiplier is easily removed to permit visual observations of reflections, particularly for line-up purposes. The rotation of the crystal about a vertical axis is coupled with the rotation of a table on which a stereographic projection is automatically drawn. After each complete rotation of crystal and table about this vertical axis, the elevation of the plane of the optical system is raised by 0.5°. A marking device is moved in, radially toward the center of the table, therewith, by a simple coupling system which produces a motion corresponding exactly to that required for a stereographic projection. A light signal received by the photomultiplier actuates the marker, so that a reflection is recorded on a paper placed on the rotating table. The azimuthal and elevation angles are then read on a standard Wulff net. Reproductions of

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the first stereographic projections to be obtained with the instrument, from an imperfect crystal of $\text{Li}_2\text{CrO}_4 \cdot \text{K}_2\text{SO}_4$ are shown and discussed.

1531

Pennsylvania State U. Groth Inst., University Park.

CONCERNING APRIL 25-26 CONFERENCE AT THE PENNSYLVANIA STATE UNIVERSITY, by R. Pepinsky. May 1, 1958 [25]p. incl. illus. diags. (Rept. no. 11) (AFOSR-TN-59-316) (AF 49(638)416) AD 228906

Unclassified

In connection with the Groth Inst. program to revise Paul von Groth's Chemische Krystallographie (see item no. 1527, Vol. III), a conference of American editors, contributors, and other interested crystallographers was to be held at the Groth Inst. on Apr. 25-26, 1958, under the auspices of the Air Force Office of Scientific Research, Solid State Sciences Div. A tentative program was to include discussions on (1) the need for revision of Groth's Chemische Krystallographie, and its preparation; (2) the status and coordination of crystallographic data; (3) abstracting procedures and IBM handling computing and tabulation; (4) and many other related topics.

1532

Pennsylvania State U. Groth Inst., University Park.

PRELIMINARY EXPERIMENTAL ABSTRACT ON AMMONIUM SULFATE, by R. Pepinsky and V. Vand. Mar. 17, 1958 [43]p. incl. tables. (Rept. no. 12) (AFOSR-TN-59-317) (AF 49(638)416) AD 228907

Unclassified

A sample abstract on ammonium sulfate is examined. It is intended to serve several purposes. First, it is an experimental abstract covering future stages of activity of the Groth Inst. to provide material for testing the efficiency of machine card handling systems, which are not yet in operation but which have to be planned well in advance. Second, it serves as a sample to estimate the approximate size of the work ahead. Third, it provides a tangible example of a style which is obtainable by the use of automatic machine data-handling methods, with minimum of human intervention. Fourth, estimates can be made of the probable usefulness of such an abstract. (Contractor's abstract)

1533

Pennsylvania State U. Groth Inst., University Park.

DEFINITIONS AS OF JUNE 11, 1958 FOR ABSTRACTING FOR THE GROTH INSTITUTE, by R. Pepinsky and V. Vand. June 11, 1958, 1v. (Rept. no. 13) (AFOSR-TN-59-318) (AF 49(638)416) AD 228908

Unclassified

This report lists the definitions adopted in the Groth Inst. Abstracts to this date. The report is divided into 3 parts. Part 1 lists short definitions, in alphabetical order of the operation abbreviations. This is useful for ascertaining whether a given abbreviation has already been used, and for quick information. Part 2 lists the short definitions according to subject. Here all abbreviations for electrical, thermal, optical, etc., properties are grouped together. Part 3 gives full definitions of abbreviations, together with their units and scales, and it also defines into which fields the numerical values are placed, and where decimal points and remarks are placed.

1534

Pennsylvania State U. Groth Inst., University Park.

THE IBM CARD LITERATURE IMAGE (STAGE I) OF A SECTION OF THE BARKER INDEX, TETRAGONAL STRUCTURE, by V. Vand and R. Pepinsky. Aug. 30, 1958, 255p. (Rept. no. 14) (AFOSR-TN-59-319) (AF 49(638)416) AD 228909

Unclassified

This report represents the first step in the Groth Inst. data-processing system. The data was punched onto IBM cards and tabulated directly onto multilith mats, from which the report was printed. It covers all the tetragonal structures contained in the Barker Index, and the cards are arranged in much the same order as in the Barker Index. In the present tabulation, some numerical fields are not easily legible as the numbers of successive fields run into each other. This is a space-saving feature, since for machine processing, number spacing is not necessary. Future reports will be tabulated on a cardatype printer, where it will be possible to punctuate automatically by machine. This report should be used in conjunction with item no. 1535.

1535

Pennsylvania State U. Groth Inst., University Park.

THE PROPERTY SORT (STAGE 2) OF A SECTION OF THE BARKER INDEX, TETRAGONAL STRUCTURES, by V. Vand and R. Pepinsky. Aug. 30, 1958, 239p. (Rept. no. 15) (AFOSR-TN-59-320) (AF 49(638)416) AD 228910

Unclassified

This report represents the 2nd stage in the Groth Inst. processing system (see item no. 1534 for stage 1), in which the cards are tabulated according to the property abbreviation punched in the card columns 8-10. In order to facilitate reading of the report, heading cards have been inserted at the heads of each sort section, each heading card carrying a short definition of the abbreviation. This report can directly answer any simple property questions on tetragonal crystals. Complex questions requiring logical "and" and "or" can be answered by a programmed search on an electronic digital

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computer. The cards are pre-sorted within each property, so that only a limited amount need to be taken to the computer at any one time for processing.

1536

Pennsylvania State U. Groth Inst., University Park.

OPERATIONAL NOTES FOR IBM CARD OPERATORS, by V. Vand and R. Pepinsky. Sept. 30, 1958 [11]p. (Rept. no. 16) (AFOSR-TN-59-321) (AF 49(638)416) AD 228911
Unclassified

The activities of the IBM card operators involve card keypunching, verifying, correcting, tabulating for proof-reading, tabulating on multilith mats, sorting, and card filing into cabinets. The operations in this group which are necessary to the production of Uncritical Monographs are described in detail.

1537

Pennsylvania State U. Groth Inst., University Park.

EXAMPLE OF FIVE GROTH INSTITUTE REQUEST REPORTS, by V. Vand and R. Pepinsky. Dec. 10, 1958, 1v. (Rept. no. 17; request repts. nos. 1R-5R) (AFOSR-TN-59-322) (AF 49(638)416) AD 228912
Unclassified

Examples are given of 5 requests received by the Groth Inst. for retabulation of selected data from the Barker Index (contained in item no. 1534). They were: (No. 1R) Tabulate crystal cell ratios of all tetragonal crystals with the chemical names listed as well as the Barker Index numbers; (No. 2R) Tabulate habits of tetragonal crystals, also with chemical names listed; (No. 3R) Tabulate various optical properties of tetragonal crystals with their chemical names listed; (No. 4R) Tabulate twinning of tetragonal crystals with chemical names listed; and (No. 5R) Tabulate polymorphism of tetragonal crystals with chemical names listed. All of the 5 requests were handled jointly and involved the processing of approx 3000 IBM cards in a total of 15 man-hr. It is expected that in the future, requests of this size may be processed within 24 hr from the receipt of the request.

1538

Pennsylvania State U. Groth Inst., University Park.

TETRAGONAL STRUCTURES ARRANGED ACCORDING TO INCREASING CRYSTAL CELL RATIOS, by V. Vand and R. Pepinsky. Dec. 30, 1958, 255p. (Rept. no. 18; request rept. no. 6) (AFOSR-TN-59-323) (AF 49(638)-416) AD 228913
Unclassified

This request report represents a section of the Barker Index, containing the same IBM cards which were tabulated in items nos. 1534 and 1535; but here the com-

pounds are arranged according to increasing crystal cell ratios. This tabulation contains 8600 IBM cards and took only 15 man-hr to prepare, excluding the time spent on abstracting, preparation and presorting of the original cards, and multilithing of the reports.

1539

Pennsylvania State U. Groth Inst., University Park.

LIST OF CODE WORDS FOR PERIODICALS, AND SOME COMMENTS ON OTHER REFERENCE SYMBOLS, by M. Neuberger, V. Vand, and R. Pepinsky. Mar. 9, 1959 [98]p. (Rept. no. 19) (AFOSR-TN-59-324) (AF 49(638)416) AD 228913
Unclassified

This list supersedes the List of Definitions of Abbreviations for Periodicals (item no. 1529, Vol. III), issued on Apr. 21, 1958. Code words for periodicals are formed from the journal name in the original language. The list is arranged alphabetically according to the 3-letter code words used. This is followed by the most common abbreviation, as found in the literature, in capitals. The full title, if fully known, is then given under the abbreviation together with the place of publication. Distinguishing symbols for publications other than journals or periodicals are discussed briefly.

1540

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 2L) OF HEXAGONAL CRYSTALS IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Mar. 16, 1959, 135p. (Rept. no. 22) (AFOSR-TN-59-325) (AF 49(638)416) AD 228915
Unclassified

A tabulation of the Hexagonal section of the Barker Index of Crystals is presented. The data are in the form of a literature image on IBM cards, and the arrangement is the same as that used in the Barker Index. The present tabulation represents the 1st full-scale report produced on the Groth Inst. Cardatype printer.

1541

Pennsylvania State U. Groth Inst., University Park.

SPECIFICATIONS FOR THE GROTH INSTITUTE IBM 704 PROGRAMS, by V. Vand and R. Pepinsky. Mar. 23, 1959, 7p. (Rept. no. 23) (AFOSR-TN-59-326) (AF 49(638)416) AD 228916
Unclassified

Detailed specifications for the IBM 704 programs have been formulated, based on the need for an efficient multi-job processing system where one program normally follows another without any machine stops.

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1542

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 4L) OF ORTHORHOMBIC CRYSTALS INDEX NUMBERS 500-999 IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Apr. 15, 1959, 179p. (Rept. no. 25) (AFOSR-TN-59-502) (AF 49(638)-416) AD 228894
Unclassified

Report 4L, issued as Groth Institute Report No. 25, comprises the literature image of the second part of the Orthorhombic Section of The Barker Index of Crystals, Volume I, Part II. (Contractor's abstract)

1543

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 3L) OF ORTHORHOMBIC CRYSTALS INDEX NUMBERS 0-499 IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Apr. 1, 1959, 185p. (Rept. no. 24) (AFOSR-TN-59-503) (AF 49(638)416) AD 228893
Unclassified

Report 3L, issued as Groth Institute Report No. 24, comprises the literature image of the first part of the Orthorhombic Section of The Barker Index of Crystals, Volume I, Part II. Orthorhombic Index Numbers 1-0 through 499-0 are included. It is to be noted that our IBM Card-a-type is not yet equipped with numerical zero which is properly distinguishable from capital O. Barker Index number 320 for the orthorhombic system presently appears as BI 3200, for example. (Contractor's abstract)

1544

Pennsylvania State U. Groth Inst., University Park.

FIRST EXAMPLE OF AN AUTOMATIC PRINTOUT FROM THE GROTH INSTITUTE ABSTRACT IBM CARDS, by R. Pepinsky and V. Vand. Feb. 25, 1958 [25]p. incl. tables. (Rept. no. 1) (AFOSR-TN-59-1049) (AF 49(638)416) AD 228887
Unclassified

This is an early example of the automatic printout whose purpose is to demonstrate the feasibility of the abstracting system adopted, and to test the convenience of the abbreviations used. The first section lists the definitions of operator symbols used. Since then, some symbols have been changed; for example, the symbols A/B and C/A have been replaced by ARB and CRA, in order to assist fast sorting procedures. The second part includes samples of abstracts from various sources. The style of the chemical formulae has been changed, the present rule being that any chemical element symbol must be preceded by a blank. The third part shows examples of data sorted according to the operator. This should be valuable for determinative purposes.

The fourth and the fifth parts list the abbreviations adopted for periodicals. There are 26³ combinations of three letters possible, and these should be sufficient to describe some 17,576 periodicals before the system becomes exhausted. The sixth part shows various experiments in expressing chemical formulae, which are, however, now abandoned. Included is a typical Groth Institute form as filled in by an abstractor, a layout of an IBM card used, and an example of an Abstract Form, as supplied to the abstractors.

1545

Pennsylvania State U. Groth Inst., University Park.

AN EXAMPLE OF AN AUTOMATIC TABULATION OF THE GROTH INSTITUTE ABSTRACT IBM CARDS IN VARIOUS CATEGORIES, by R. Pepinsky and V. Vand. Apr. 2, 1958 [26]p. incl. tables. (Rept. no. 6) (AFOSR-TN-59-1050) (AF 49(638)416) AD 228888
Unclassified

Automatic tabulation of the Groth Institute abstract IBM cards according to authors, properties, etc., is described which serves as another example of types of machine output. This tabulation contains too few entries to be really useful; several books have to be covered in order to obtain collations of real value. A list of abbreviations precedes the categorized tabulations. Several points are of interest. In the author index, the continue column reveals whether a single author was mentioned, or whether the reference has joint authors. In the former instance, the continue column is blank (example, 1200 AUT Bolland); in the latter instance, it reveals the order in the joint authorship (example, 3090 AUT3 Berry reveals that Berry is the third joint author). In the formula index, the style is not completely stabilized, especially for hydrates. The final formula style to be adopted will depend on the convenience of control of the upper and lower case of the Cardatype machine. It is likely that a comma instead of a period will be used to separate the water of hydration; otherwise the number of water molecules will be printed as subscripts, which is undesirable. (Contractor's abstract)

1546

Pennsylvania State U. Groth Inst., University Park.

EXAMPLE OF AN ABSTRACT: A PORTION OF THE BARKER INDEX, by R. Pepinsky and V. Vand. Apr. 23, 1958 [29]p. incl. tables. (Rept. no. 7) (AFOSR-TN-59-1051) (AF 49(638)416) AD 228889
Unclassified

The present report shows an example of a Groth Institute abstract of a portion of the Barker Index of Crystals. The multilith mats used for reproduction were obtained directly from an IBM 407 Tabulator, using a multilith ribbon in place of the standard ribbon, and the data was furnished to the Tabulator on punched

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cards. The 407 Tabulator prints information simultaneously from 120 print wheels, at a rate of up to 18,000 characters a min. The IBM punched cards are read and tabulated at the rate of 150 per min or 9000 per hr. One report page is printed from 35 IBM cards. The present report contains 26 pages, and the entire set of mats required only 6 min for their complete preparation. The 407 Tabulator has upper case characters only, so that the writing of chemical formulae must be adapted to upper case only. This is a difficulty with which we must put up, and to which readers must accustom themselves, until the alternative output printing system is available to us. In any case, 407 Tabulator output will probably be relied on for intermediate-stage reports, because of its high speed. It is noted that the 407 Tabulator adds extra blank columns to improve readability of the text. Thus on the original card

20 COM G ZINN

the G was punched in Format column 12, indicating that the compound name is in German. The word ZINN followed immediately in card column 13-16. On the print-out, 2 blanks separate it from G. It is interesting to compare the legibility of type in the present report with that in Report No. 1. The latter printouts were photographically reproduced, at much greater cost than the direct mat printout used here. The advantages of the present reproduction system are evident. (Contractor's abstract)

1547

Pennsylvania State U. Groth Institute, University Park.

LIST OF ABBREVIATIONS USED IN ABSTRACTING THE BARKER INDEX OF CRYSTALS, by R. Pepinsky and V. Vand. May 1, 1958 [5]p. (Rept. no. 8) (AFOSR-TN-59-1052) (AF 49(638)416)

Unclassified

The abbreviations used in abstracting the Barker Index of Crystals are listed and explained. All entries in the index are consecutively numbered, such as T. 5 to indicate the 5th tetragonal structure described. Thus the Working Reference BI 5T means Barker Index, entry T. 5. Some of the abbreviations are as follows: COM-Compound, POL-Polymorphism, ANC-Barker Classification angle of crystal, CCR-crystal cell ratios, CLR-Color, etc. Explanations of each of these are given, such as FOR. Chemical formulae have upper and lower case. Note that $\text{Fe}_2\text{O}_3 \cdot 12\text{H}_2\text{O}$ has upper case F;O;1;2;H, lower case e,₂;3;2. Machines are to be told which is upper case and which is lower case. The machines operate in 3 modes. U mode: everything is in upper case. L mode: everything is in lower case. S mode: the 1st letter encountered is upper case, all that follows is lower case. Rule: in chemical formulae the machine is instructed to go into S mode whenever it meets a blank, and go into U when-

ever it meets a comma (,). Thus if the above formula is written FE2 O3,12 H2 O, the machine interprets the formula correctly. Examples of other uses are also given.

1548

Pennsylvania State U. Groth Inst., University Park.

SUGGESTED AGREEMENT FORM FOR CORRESPONDING MEMBERS OF THE GROTH INSTITUTE, by R. Pepinsky and V. Vand. May 1, 1958 [5]p. (Rept. no. 9) (AFOSR-TN-59-1053) (AF 49(638)416) AD 228890

Unclassified

A form is presented to be filled out and mailed back to the Groth Inst. in order to be placed on its mailing list of various reports and tabulations. It is particularly addressed to abstractors, proof-readers, data reviewers, and data processors, and is offered in return for a certain amount of assistance to the inst.

1549

Pennsylvania State U. Groth Institute, University Park.

SUMMARY OF NEEDS FOR IBM COMPUTING EQUIPMENT FOR THE GROTH INSTITUTE AND THE X-RAY AND CRYSTAL STRUCTURE LABORATORY, by R. Pepinsky and V. Vand. May 1, 1958 [5]p. (Rept. no. 10) (AFOSR-TN-59-1054) (AF 49(638)416) AD 228891

Unclassified

This report discusses the equipment used at the Groth Inst. and its cost. The future needs are briefly outlined, and the locations at which certain facilities are made available are acknowledged. At the time of this report the requirements included three 026 punches, one 858 cardatype, one 082 sorter, one 407 tabulator, one 56 verifier, and 50 card files, 20 drawer.

1550

Pennsylvania State U. Groth Inst., University Park.

RESEARCH ON MODERN CRYSTALLOGRAPHY AT THE GROTH INSTITUTE, by V. Vand and R. Pepinsky. Jan. 30, 1959 [2]p. (Rept. no. 20; progress rept no. 4P) (AFOSR-TN-59-1055) (AF 49(638)416) AD 228884

Unclassified

Progress made to date at the Groth Inst. is briefly discussed. Abstractors have concentrated on Groth's *Chemische* and volume I has been completed. All 50,000 cards have been converted to the new upper-lower case style. Tabulating procedures are reported as behind schedule which has delayed the proof-reading schedule also. Two IBM 704 programs for computation of refractive index differences have been completed and debugged. Progress on various other operational phases are also discussed.

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1551

Pennsylvania State U. Groth Institute, University Park.

USE OF A SIMPLE INFORMATION RETRIEVAL SYSTEM IN THE GROTH INSTITUTE, by V. Vand and R. Pepinsky. Feb. 16, 1959 [5]p. (Rept. no. 21) (AFOSR-TN-59-1056) (AF 49(638)416) AD 228892
Unclassified

A brief explanation of the peek-a-boo information retrieval system is given. In this system, determination of the required document numbers containing wanted information is performed by a visual determination of matching holes in selected keyboard cards. Where the beam from a light source shines through the superimposed holes in the selected cards, the hole represents a document indexed under the keywords stated in the query. The cards are adapted to carry information for up to 500 documents. A brief explanation of the column designation is given and its use. The preparation of the peek-a-boo cards is outlined with specific instructions for punching. In general it can be said that the peek-a-boo card system provides a comparatively compact and efficient multiple search system. Its disadvantages, however, include its inability to respond to the word order and its inability to distinguish combinations of words such as blue-green or green-blue.

1552

Pennsylvania State U. Groth Institute, University Park.

THE LITERATURE IMAGE (REPORT NO. 5L) OF ORTHORHOMBIC CRYSTALS INDEX NUMBERS 1000-1499 IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Aug. 3, 1959 [185]p. Incl. tables. (Rept. no. 26) (AFOSR-TN-59-1057) (AF 49(638)416) AD 228895
Unclassified

This report comprises the literature image of the second part of the Orthorhombic Section of The Barker Index of Crystals, Volume I, Part II. Orthorhombic Index numbers 1000-0 through 1499-0 are included. (Contractor's abstract)

1553

Pennsylvania State U. Groth Institute, University Park.

OPERATIONAL NOTES FOR IBM CARDTYPE OPERATORS, by V. Vand and R. Pepinsky. May 30, 1959 [2]p. (Rept. no. 37) (AFOSR-TN 59-1058) (AF 49(638)416) AD 228895
Unclassified

Instructions for operation of the IBM Cardtype are presented. These are given in the form of 19 rules starting with the checking of report numbers. Each tabulating operation is followed by a proofreading instruction.

tion. The operation also utilizes xerox photographing of the corrected material. Much emphasis is placed on the verifying that all information is correct and complete.

1554

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 6L) OF ORTHORHOMBIC CRYSTALS INDEX NUMBERS 1500-1999 IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Aug. 17, 1959 [180]p. Incl. tables. (Rept. no. 27) (AFOSR-TN-59-1059) (AF 49(638)416) AD 228896
Unclassified

This report is comprised of the literature image of the second part of the Orthorhombic Section of The Barker Index of Crystals, Volume I, Part II. Orthorhombic Index numbers 1500-0 through 1999-0 are included. (Contractor's abstract)

1555

Pennsylvania State U. Groth Inst., University Park.

THE LITERATURE IMAGE (REPORT NO. 7L) OF ORTHORHOMBIC CRYSTALS INDEX NUMBERS 2000-2156 IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Aug. 24, 1959 [56]p. Incl. tables. (Rept. no. 28) (AFOSR-TN-59-1060) (AF 49(638)416) AD 228897
Unclassified

This report is comprised of the literature image of the second part of the Orthorhombic Section of The Barker Index of Crystals, Volume I, Part II. Orthorhombic Index numbers 2000-0 through 2156-0 are included. (Contractor's abstract)

1556

Pennsylvania State U. Groth Inst., University Park.

PROPERTY SORT (REPORT NO. 2S) OF HEXAGONAL CRYSTALS INDEX NUMBERS 1-434 IN THE BARKER INDEX OF CRYSTALS, VOLUME I, PART II, by V. Vand and R. Pepinsky. Aug. 31, 1959 [133]p. Incl. tables. (Rept. no. 29) (AFOSR-TN-59-1061) (AF 49(638)416) AD 228898
Unclassified

This report involves the same IBM cards as those tabulated in the Report No. 22 (Report No. 2L), The Literature Image, of a section of The Barker Index, Hexagonal Crystals. This is the 2nd stage (Property Sort) in The Groth Institute processing system, in which the cards are tabulated according to the property abbreviation punched in the card columns 8-10. Heading cards have been inserted at the heads of each sort section, carrying a Short Definition of each abbreviation. (Contractor's abstract)

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1557

Pennsylvania State U. Groth Inst., University Park.

USE OF THE CARDATYPE MACHINE TO PREPARE PEEK-A-BOO CARDS, by R. Maunski, V. Vand, and R. Pepinsky. Aug. 7, 1959 [14]p. incl. illus. tables. (Rept. no. 30) (AFOSR-TN-59-1227) (AF 49(638)416) AD 228899 Unclassified

A method of preparation of Peek-A-Boo cards on the IBM 858 Cardatype Machine is presented. The procedure begins by placing the original abstract cards into groups which contain the required information. These cards are then sorted in order by compound number. The original cards are placed in the Cardatype Machine, and the Key Punch spaces to the appropriate column, punches the last digit, and awaits the next card. The card is then read into the Arithmetic Unit, and the spaces already taken are subtracted from the spaces to be made. A card of space 4 and punch 1 gives 4 spaces, allowing the card to have a number 1 punched in column 4. The next card with space 6 and punch 1 gives 2 spaces, because the 4 spaces previously taken are subtracted from it. This permits the card to have a number 1 punched in column 6. This then produces the 10 provisional cards which have all 1's, 2's, 3's, etc. punched on them. These cards are then duplicated onto 1 card, which is the final Peek-A-Boo card. Examples of this procedure are given. A method of wiring to produce numerical Peek-A-Boo cards on 858 Cardatype Accounting Machine and a new system of using the 407 Tabulator in addition to the Cardatype are discussed also.

1558

Pennsylvania State U. Groth Inst., University Park.

GROTH INSTITUTE EXTRACTOR'S MANUAL, FIRST REVISED EDITION, PART II: SPECIFIC DIRECTIONS AND DEFINITIONS OF OPERATIONS, by R. Pepinsky and V. Vand. Oct. 1, 1959, 75p. incl. illus. tables. (Rept. no. 32) (AFOSR-TN-59-1228) (AF 49(638)416) AD 228901 Unclassified

The purpose behind the preparation of this new edition of the Groth Institute Extractor's Manual, previously issued as Groth Institute Report No. 13, are 3-fold: to facilitate necessary reorganization of extracting procedures within the Institute proper, as has been shown necessary after a year and a half of experience; to reduce the possibility of errors in the entire retrieval system, and to assist in the organization and operation of extracting centers outside of the Institute but collaborating with it. Material from the extracting section should flow to the IBM section with a minimum of corrections and revisions. The filled-in extractors' forms are submitted to checkers, who compare the data with the original information from which the extracting was done. The extract forms are next submitted for IBM card punching and verifying. The verified cards are then submitted for fast tabulation on the IBM 407, and

these tabulations are examined by checkers. After correcting cards are punched, a second tabulation is made on a Cardatype machine. The 1st Cardatype tabulation is read by checkers and then by knowledgeable editors. A 2nd Cardatype tabulation is then accomplished, and cards are duplicated in the Cardatype punch. The corrected Cardatype printouts are then transferred by xerography to reproducing mats, for report reproduction. (Contractor's abstract)

1559

Pennsylvania State U. Groth Inst., University Park.

GROTH INSTITUTE EXTRACTOR'S MANUAL FIRST REVISED EDITION, PART III: LISTING OF CODE WORDS FOR PERIODICALS, by R. Pepinsky and V. Vand. Oct. 1, 1959, 201p. incl. tables. (Rept. no. 33) (AFOSR-TN-59-1229) (AF 49(638)416) Unclassified

Several lists of code words for periodicals are presented in alphabetical form. They include alphabetical indexes of code with journal abbreviations, of journal title abbreviations, of code with journal titles, of country and city, and of journal titles. Typical examples would be ACJ as a code for the journal abbreviation, AM. CHE., J. AJP is the code, listed alphabetically, for the journal title American Journal of Pharmacy. The country and city index is alphabetically constructed by country 1st and then city of the journal publication site.

1560

Pennsylvania State U. Groth Inst., University Park.

ABSTRACTS OF THREE PAPERS ON THE STATUS OF THE GROTH INSTITUTE PROGRAM. I: ORGANIZATION AND PROGRAM. II: DATA-HANDLING PROCEDURES. III: IBM 704 PROGRAMMING, by R. Pepinsky, V. Vand and others. July 1, 1959 [7]p. (Rept. no. 35) (AFOSR-TN-59-1230) (AF 49(638)416) Unclassified

Part I presented at Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

Presented at meeting of the Amer. Cryst. Assoc. Cornell U., Ithaca, N. Y., July 19-24, 1959.

I. Organization and Program - The Groth Institute program is designed to record all available crystal data on IBM punched cards and subsequently transfer it to magnetic tape for handling and computation by IBM 704 computers. The system facilitates machine searching, sorting, collating and indexing of the data. The program presently produces a 100-page report of abstracted data a wk. II. Data-Handling Procedures - Reports can be prepared at each stage of IBM processing: the literature image, the property sort, the uncritical compound monograph, and the critical compound

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monograph. At any of these stages, the information can also be retrieved. The IBM 704 or 706 computers can extract any combination of information from magnetic tapes. The Institute system presently contains over 1/2 million IBM cards, and is handling approx 1000 compounds per wk. III. IBM 704 Programming - The Groth Institute library consists of approx 1 doz running programs, including one for refractive indices, calculating of powder data from single-crystal data, a peek-a-boo retrieval program, calculating of formula weights, formula translation, and symmetry search.

1561

Pennsylvania State U. Groth Inst., University Park.

SUMMARY REPORT ON THE GROTH INSTITUTE, by R. Pepinsky. Oct. 21, 1959, 5p. (Rept. no. 36) (AFOSR-TN-59-1231) (AF 49(638)416) AD 228902
Unclassified

In the Groth Institute scheme, information is abstracted and transferred to IBM punched cards, and subsequently to IBM binary-coded-decimal (BCD) tape or RAMAC discs, for a variety of collations, crystallographic computations, and print-outs-on-demand-from tape- and card-controlled tabulators and typewriters. The fundamental principles of the Institute system are: (1) all crystal data are transferred, after suitable abstracting, to punched cards, in a succinct form which permits identification of crystal species, reference source, and nature of the data; (2) each data card is characterized by operator, which informs the computer what can be or is to be done with the information; (3) collation and indexing of data, all feasible computations, and printouts, are possible automatically; (4) the information of crystal chemistry and physics is thus available implicitly in the storage, programs and tabulations of the machine; (5) no attempt is made to publish all of the best mass of available or computable information in crystallography; instead, it is automatically printed, as desired for special needs, monographs and summaries, on demand; (6) all data is automatically prepared for small-scale, nonmechanized search, using the Peek-A-Boo system.

1562

Pennsylvania State U. Groth Inst., University Park.

PROPERTY SORT (REPORT NO 3S) OF ORTHORHOMBIC CRYSTALS, INDEX NUMBERS 0-499, IN THE BARKER INDEX OF CRYSTALS, VOL. 1, PART II, by V. Vand and R. Pepinsky. Nov. 1, 1959, 175p. incl. tables. (Rept. no. 39) (AFOSR-TN-59-1232) (AF 49(638)416)
Unclassified

This report involves the same IBM cards as those tabulated in the Report No. 24 (Report 3L). This is the second state (Property Sort) in The Groth Institute processing system, in which the cards are tabulated according to the property abbreviation punched in the card

columns 8-10. Heading cards have been inserted at the heads of each sort section, carrying a short definition of each abbreviation. When all property sorts for the orthorhombic system have been tabulated in this manner, a merged property sort for that system will be prepared. This will of course be accomplished as well for all other sections of the Barker Index. Merging of the property sorts for the entire Index will be accomplished finally. (Contractor's abstract)

1563

Pennsylvania State U. Groth Inst., University Park.

[PHOTO-COPY OF] CHEMISCHE KRYSTALLOGRAPHIE. VOLUMES I, II, III, IV, AND V, by P. Groth. Dec. 30, 1959, 5v. incl. diagrs. tables, refs. (AF 49(638)416)
Unclassified

This photo-reproduction of Paul von Groth's *Chemische Krystallographie*, now long out of print, has been prepared and issued by the Groth Institute College of Chemistry and Physics in order to assist co-workers of the Institute in the re-editing of this work. The new edition will be entitled *Groth's Encyclopedia of Chemical and Physical Crystallography, Revised Edition*. The program for this revision is described in *Concerning Establishment of The Groth Institute and Revision of Groth's Chemische Krystallographie*, by R. Pepinsky (see item no. 1527).

1564

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY STUDIES OF COMPLEX IONS AND THEIR SALTS WITH ORGANIC BASES AND ORGANIC OXYGEN COMPOUNDS, by R. Pepinsky. Summary final rept. Oct. 1, 1959, 4p. (AFOSR-TR-59-184) (AF 18-(600)1556)
Unclassified

The research under this contract involves the development of a method whereby molecules to be studied can be crystallized in structures whose x-ray analysis would be certain of success. In essence, the method involves precipitation in crystalline form of the organic molecule, generally in ionic form, but diluted structurally by sizeable groups of atoms of the class known as complex ions, which dominate the packing of the structures. The structure of these complex ions is generally known, and in any case readily determined. They contain heavier atoms of the sort necessary for application of the classical heavy-atom x-ray method. A brief outline is given of the studies accomplished by this method.

1565

Pennsylvania State U. X-Ray and Crystal Analysis Lab., University Park.

THE CRYSTAL STRUCTURE OF TRIS(THIOUREA)

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COPPER(I)CHLORIDE, $\text{Cu}(\text{SCN}_2\text{H}_4)_3\text{Cl}$, by C. B.

Knobler, Y. Okaya, and R. Pepinsky. [1959] [13]p. Incl. diags. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1556, Office of Naval Research under N6onr-26916, National Institutes of Health and Shell Oil Company)

Unclassified

Published in Zeitschr. Krist., v. 111: 385-397, Oct. 1959.

Tris(thiourea)copper(I) chloride crystallizes in the tetragonal system with $a = 13.41\text{\AA}$, $c = 13.79\text{\AA}$; the space group is $P4_12_12$ or its enantiomorph $P4_32_12$.

The crystal structure was determined using full 3-dimensional x-ray data. The structure is ionic, with chloride ions and infinite spiral chains of $[\text{Cu}(\text{thiourea})_3]^+$. The latter shows the usual tetrahedral con-

figuration for monovalent copper by sharing 1 of the 3 sulfur atoms of the thiourea ligands; the tetrahedron around the copper is slightly distorted, with Cu-S distances ranging from 2.31₃Å to 2.42₄Å and

S-Cu-S angles from 110° to 118°. A planar configuration is observed around the shared sulfur atom involving the 2 copper atoms and carbon atom of the thiourea ligand. The N-H...Cl hydrogen bonds and the configurations of the thiourea ligands are discussed. (Contractor's abstract)

1566

Pennsylvania State U. [X Ray and Crystal Analysis Lab.] University Park.

ABSOLUTE CONFIGURATION OF FERROELECTRIC CRYSTALS, I. TETRAGONAL BaTiO_3 (Abstract), by Y.

Okaya, R. Pepinsky, and F. Unterleitner. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Atomic Energy Commission, and Signal Corps) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 63, Jan. 28, 1959.

Pepinsky and Okaya have pointed out that the absolute configuration of tetragonal ferroelectric PbTiO_3 could

be established from a map of the function $P_g(u) =$

$$\sum \Delta F_H^2 \sin 2H\pi \cdot H \cdot u, \text{ when MoK}\alpha \text{ x-rays are employed. A}$$

program for determination of absolute configurations of several ferroelectric structures is in progress, using such anomalous dispersion effects. The structure of tetragonal BaTiO_3 has been established by neutron dif-

fraction, and shifts from cubic positions accurately determined. No evidence of the direction of these shifts with respect to an applied field is achievable with neu-

trons. Using $\text{CoK}\alpha$ x-rays to excite the barium ions,

clearly observable differences $\Delta F_H^2 = |F_H^2| - |F_{-H}|^2$

are obtained. The signs of these agree well with the model based on the assumption that the Ti ion moves in the field direction.

1567

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

A NEW CLASS OF FERROELECTRICS: ACID SELENITES (Abstract), by R. Pepinsky, K. Vedam and others.

[1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Atomic Energy Commission, and Signal Corps) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 63, Jan. 28, 1959.

Optical observation of a reversible transition in potassium acid selenite has led to the dielectric examination of other acid selenites. Two new ferroelectric species have therewith been discovered: $\text{LiH}_3(\text{SeO}_3)_2$, ferroelectric at room temperature; and $\text{NaH}_3(\text{SeO}_3)_2$, ferroelectric below -75°C. $\text{LiH}_3(\text{SeO}_3)_2$ shows well-saturated square hysteresis loops over the temperature range from -190°C to +80°C. At room temperature the spontaneous polarization is 10.0 microcoulombs/cm², and the coercive field is 1.5kv/cm. X-ray observations reveal monoclinic symmetry, space group Pn, with $a = 6.255\text{\AA}$, $b = 7.899\text{\AA}$, $c = 5.443\text{\AA}$, $\beta = 105^\circ 23'$. The polar axis is perpendicular to the (001) plane. The material appears to be of practical importance. $\text{NaH}_3(\text{SeO}_3)_2$ is not isomorphous with $\text{LiH}_3(\text{SeO}_3)_2$. In the room-temperature phase the symmetry is monoclinic, space group P_{21}/a , with $a = 11.77\text{\AA}$, $b = 4.84\text{\AA}$, $c = 5.80\text{\AA}$, $\beta = 118.5^\circ$. The ferroelectric phase has triclinic symmetry (space group P1; if axes are denoted as for room-temperature phase, space group C). The polar direction is along [310], referred to the monoclinic phase.

1568

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

PHASE TRANSITIONS IN HEXAFLUOPHOSPHATE SALTS (Abstract), by K. Vedam, R. Pepinsky and others.

[1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Atomic Energy Commission, and Signal Corps) Unclassified

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Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 63, Jan. 28, 1959.

$\text{NH}_4\text{PF}_6 \cdot \text{NH}_4\text{F}$ is tetragonal at room temperature, and has 2 low-temperature transitions: at -45°C ($= T_{uc}$) and at -101°C ($= T_{LC}$). Both low-temperature phases are orthorhombic. The dielectric constant $\epsilon_{[110]}$ exhibits a small anomaly at T_{uc} , and a pronounced anomaly at T_{LC} . X-ray examination reveals superstructuring along the a and b axes below T_{uc} , and a doubling of the c axis below T_{LC} . The lowest phase is antiferroelectric. A detailed structural investigation is required to reveal the dielectric character of the intermediate phase. An order-disorder transition has been observed in KPF_6 at 4°C . A detailed x-ray structure analysis reveals hindered rotation of the $(\text{PF}_6)^{-1}$ octahedra.

A large thermal anomaly at the transition temperature suggests a "freezing in" of the hindered rotations in the lower phase.

1569

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

THE USE OF ANOMALOUS DISPERSION FOR DIRECT X-RAY ANALYSES OF NON-CENTRIC CRYSTAL STRUCTURES (Abstract), by R. Pepinsky. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], National Institutes of Health, and Office of Naval Research) AD 418316

Unclassified

Presented at Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

The $P_s(u)$ function, defined as $P_s(u) = \sum_H |F_H|^2 \sin 2\pi H \cdot u$,

has proved of great power in the direct analyses of the structures and absolute configurations of a number of non-centric crystals containing scatterers of atomic number 16 (sulfur) or greater. In one recent example of the method, the structure and hand of ferroelectric $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$, as a function of electric field direction, were directly observable in $P_s(u)$, using $\text{CuK}\alpha$ radiation with proportional-counter intensity measurements and making use of the imaginary component of the sulfur structure factor. This analysis established unquestionably the superiority of use of $P_s(u)$ over use of the simultaneous quadratic equations method, involving individual structure factor pairs F_H and F_{-H} . In other analyses, the structures and absolute configurations of ferroelectric BaTiO_3 and KD_2AsO_4 were simi-

larly established, with respect to the direction of the polarizing electric field; and determination of the absolute configuration of ferroelectric Rochelle salt as a function of field direction is in process of establishment, using the imaginary component of potassium scattering $\text{CuK}\alpha$ radiation.

1570

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY ANALYSES OF THREE ORGANIC NATURAL PRODUCTS (Abstract), by R. Pepinsky. [1959] 2p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, National Institutes of Health, and Office of Naval Research) Unclassified

Presented at meeting of Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

The crystal structures of the antibiotic aureomycin-HCl and 2 hydrohalide salts of the alkaloid gelsemine have been solved in 3 dimensions and refined by least-squares and differential syntheses. The earlier-reported structure of cobaltous aspartate tri-hydrate has been further refined by least-squares. R-factors for aureomycin-HCl, gelsemine-HCl and cobalt aspartate are respectively 0.15, 0.16 and 0.08, for 3-dimensional data within the $\text{CuK}\alpha$ sphere. The standard deviation of coordinates is approximately 0.02A for all 3 of these crystals. The aureomycin ($\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_3\text{Cl} \cdot \text{HCl}$) analysis

confirms the major features of the structure, but the resonance state of the molecule differs from that proposed chemically, and the dimethylamino group on ring 1 has the steric position proposed chemically for epi-aureomycin. Except for bonds to the chloride ion, only intramolecular hydrogen bonds are found; between organic portions of adjacent molecules only van der Waals contacts appear. The structure of gelsemine, $\text{C}_{20}\text{H}_{22}\text{N}_2\text{O}_2$, was previously unknown except for the existence of an oxindole nucleus, a double-bonded carbon pair in a vinyl side-chain, and a tertiary N-methyl group. The x-ray analysis completely established the configuration of the molecule in the hydrochloride and hydroiodide salts. (Contractor's abstract)

1571

Pennsylvania State U. X-Ray and Crystal [Analysis] Lab., University Park.

$\text{LiH}_3(\text{SeO}_3)_2$: NEW ROOM-TEMPERATURE FERRO-ELECTRIC, by R. Pepinsky and K. Vedam. [1959] [2]p. incl. diagrs. (AFOSR-4129) (Sponsored jointly by Force Office of Scientific Research under [AF 18(603)-35], Atomic Energy Commission, and Signal Corps) Unclassified

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Also published in Phys. Rev., v. 114: 1217-1218, June 1, 1959.

$\text{LiH}_3(\text{SeO}_3)_2$ crystallizes in the monoclinic system and exhibits useful ferroelectric properties in the entire temperature range -196°C to 90°C . The spontaneous polarization and coercive field at room temperature are $15.0 \mu\text{ coulombs/cm}^2$ and 1400 v/cm , respectively. X-ray examination reveals that the crystals belong to the space group Pn, with cell dimensions $a = 6.25 \text{ \AA}$, $b = 7.88 \text{ \AA}$, $c = 5.43 \text{ \AA}$, $\beta = 105.2^\circ$, and 2 formula units per unit cell. The polar direction is perpendicular to the (001) plane. No Curie temperature could be observed. $\text{NaH}_3(\text{SeO}_3)_2$ is not isomorphous, but is ferroelectric below -79°C . (Contractor's abstract)

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Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

CRYSTAL-STRUCTURAL MECHANISM OF THE FERROELECTRIC BEHAVIOR OF $(\text{GLYCINE})_3 \cdot \text{H}_2\text{SO}_4$ (Abstract), by R. Pepinsky. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, Office of Naval Research, and Signal Corps) Unclassified

Presented at Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

The crystal structure of ferroelectric $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$ which crystallizes at room temperature in the monoclinic system with $a = 0.417 \text{ \AA}$, $b = 12.643 \text{ \AA}$, $c = 5.735 \text{ \AA}$, $\beta = 110^\circ 23'$ was determined from full 3-dimensional x-ray diffraction data, using $\text{CuK}\alpha$ radiation. It is shown that out of the 3 glycine molecules in the crystal, 1 has the usual zwitterion configuration with the NH_3^+ group out of the plane of the other atoms; the remaining 2 glycines are mono-protonated, and planar within experimental error, and are designated as glycinium ions. Thus the chemical formula is properly written as $(\text{NH}_3^+ \text{CH}_2 \text{COO}^-) \cdot (\text{NH}_3^+ \text{CH}_2 \text{COOH})_2 \cdot \text{SO}_4^{--}$, and the compound is best described by the chemical name glycine diglycinium sulfate. It is found that 1 of the planar glycinium ions lies near but not in the plane $y = \frac{1}{2}$. The nitrogen atoms form $\text{N-H} \cdots \text{O}$ hydrogen bonds of the usual strength, whereas a quite strong $\text{O-H} \cdots \text{O}$ hydrogen bond with a distance of 2.43 \AA is found between the oxygen atom of the carboxyl group of the zwitterion glycine and that of the planar glycinium ion which lies near plane $y = \frac{1}{2}$.

1573

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

DIFFUSE X-RAY SCATTERING AND DISORDER IN $(\text{GLYCINE})_3 \cdot \text{H}_2\text{SO}_4$ (Abstract), by T. Mitsui, I. Shibuya and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35] and Signal Corps) Unclassified

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

A study of the diffuse x-ray scattering from the ferroelectric phase of $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$ has been initiated in order to obtain information about the local order, coupling of ferroelectric dipoles and the temperature dependence of these constants. This information is important in understanding the physical properties of the crystal near its Curie point. A series of Laue photographs was taken, and the intensity distribution of the diffuse scattering was measured around the (040) Bragg reflection. From the observed data, and the crystal structure, the pair-correlation functions were obtained for various neighbors. It should be emphasized that when the crystal structure is known, the pair-correlation functions are derivable from the observed diffuse scattering for any neighbors. A theory was also developed to correlate obtained results with the dielectric constant of the crystal. (Contractor's abstract)

1574

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

ON SEVERAL NEW FERROELECTRIC CRYSTALS (Abstract), by R. Pepinsky, K. Vedam, and Y. Okaya. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, Office of Naval Research, and Signal Corps) Unclassified

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

Continuation of studies on hydrogen-bonded sulfate and related anion salts has led to the discovery of several new ferroelectrics and antiferroelectrics. Certain crystal-chemical conditions become apparent which serve as guides for the discovery of new ferroelectrics. These are traceable ultimately to the pioneering discoveries of Matthias and coworkers on guanidinium aluminum sulfate hexahydrate, $(\text{NH}_4)_2\text{SO}_4$ and $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$, and related discoveries in the Penn State laboratory. These conditions are discussed. In the sulfate-selenate-fluoberyllate family, the following materials are of more recent interest: (a) $\text{NH}_4\text{NaSO}_4 \cdot 2\text{H}_2\text{O}$; (b) NH_4LiSO_4 ; (c) NH_4HSO_4 ; (d) $(\text{NH}_4)_3\text{H}(\text{SO}_4)_2$;

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(e) $\text{Li}(\text{N}_2\text{H}_5)\text{SO}_4$; and (f) RbHSO_4 . The discovery of all of these follows logically from the most important $(\text{NH}_4)_2\text{SO}_4$ case, contributed by Matthias. Isomorphous selenates, fluoberyllates and monofluophosphates of some of them have already been prepared, and others are in preparation. Properties of those already measured are given. The Li -containing salts are of particular interest, and have led to discovery of the important $\text{LiH}_3(\text{SeO}_3)_2$ discussed below. RbHSO_4 is of prime interest, since it is the first sulfate not containing ammonium or substituted ammonium ions; it is a most promising ferroelectric. The discovery of ferroelectric selenites is a natural consequence of activity in sulfates. $\text{LiH}_3(\text{SeO}_3)_2$ is a room-temperature ferroelectric with extraordinarily high spontaneous polarization. It is entirely stable, and grows easily in very large crystals. $\text{NaH}_3(\text{SeO}_3)_2$ is ferroelectric below room temperature. $\text{CsH}_3(\text{SeO}_3)_2$ is apparently antiferroelectric. Related anions are suggested by activity in the selenites, and some already prove interesting. (Contractor's abstract)

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Pennsylvania State U. [X-Ray and Crystal Analysis Lab.]
University Park.

SCADAC: SINGLE-CRYSTAL AUTOMATIC DIFFRACTOMETER AND ANALOGUE COMPUTER (Abstract), by K. Drenck, H. Diamant, and R. Pepinsky. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35] Atomic Energy Commission, and Office of Ordnance Research)

Unclassified

Presented at Internat'l. Cryst. Convention, Leningrad (U.S.S.R.), May 21-27, 1959.

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

SCADAC is one of a number of machines designed for automatic collection of single-crystal diffraction data. The machine requires reciprocal lattice vectors as input, and from these solves the Ewald construction, by means of an internal analogue computer. This computer provides information to servo amplifiers which then motor-drive the crystal and scintillation counter detector to positions satisfying the Laue conditions. The crystal and counter then scan the reflection a number of times concomitant with the required accuracy of measurement, after inserting a correct filter and proper scale factor for the scaling circuit. The counts are then printed out at pre-determined intervals of the scan angles, and are also totalized, subtracted from background, and the integrated intensities printed out, on a paper tape, along with the Miller indices, scale and filter factors. Relay circuits permit the avoidance of measurements at reciprocal lattice points where space-group symmetries produce absences. The machine is constructed in equatorial mounting, to simplify the use of the Ewald construction for non-zero level reciprocal lattice planes. It can be programmed to follow any given plane curve in reciprocal space, as well as to explore reciprocal lattice nodes.

structured in equatorial mounting, to simplify the use of the Ewald construction for non-zero level reciprocal lattice planes. It can be programmed to follow any given plane curve in reciprocal space, as well as to explore reciprocal lattice nodes.

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Pennsylvania State U. X-Ray and Crystal Analysis Lab.,
University Park.

TWO INSTRUMENTAL SYSTEMS FOR AUTOMATIC DIFFRACTION DATA COLLECTION FROM SINGLE CRYSTALS, by R. Pepinsky, K. Drenck and others. [1959] 4p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, and Office of Ordnance Research)
Unclassified

Presented at meeting of Internat'l. Union of Crystallography on Commission on Instrumentation, Stockholm (Sweden), June 10-12, 1959.

Presented in part at meeting of Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.
(Title varies)

Two schemes for automatic single-crystal diffractometry are reported. The 1st, SCADAC (single-crystal automatic diffractometer and analogue computer) is designed for rapid, accurate x-ray measurements, and includes an internal (analogue) computer which solves Laue's equation by an analogue to Ewald's construction in reciprocal space. The computer requires reciprocal lattice vectors as input. The counts are printed out at pre-determined intervals of scan angles, and are also totalized, subtracted from background, and the integrated intensities printed out on a paper tape along with the Miller indices of the reflection, the filter factor and the number of scans. The 2nd type of machine reported is an automatic machine designed and constructed for single-crystal neutron observation. The diffractometer is a miniaturized neutron goniometer which has been fitted with separate motor drives for both the crystal and counter arm shafts. Instructions for angle settings are provided to the machine in the form of 5 pre-set decade switch settings, corresponding to the crystal or counter positions for a given Laue peak for each digitalizer. All measurements and settings are automatically recorded on paper tape. The latter machine is preferable for neutron studies, because of the necessarily slow rate at which neutron measurements can be accomplished. For x-ray diffraction a machine of the SCADAC type seems preferable, and 1 machine will provide enough data for a sizable laboratory.

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Pennsylvania State U. [X-Ray and Crystal Analysis Lab.]
University Park.

X-RAY AND NEUTRON ANALYSIS OF $(\text{NH}_4)_2\text{BeF}_4$

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(Abstract), by M. Kay, J. Lajzerowicz and others. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, Brookhaven National Laboratory, Office of Naval Research, and Signal Corps)

Unclassified

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

The discovery of ferroelectricity in $(\text{NH}_4)_2\text{SO}_4$ and $(\text{NH}_4)_2\text{BeF}_4$ and subsequent studies of superstructures and non-isomorphism of the low-temperature phases of these crystals have prompted careful re-examination of their structures. X-ray and neutron analyses of the superstructured room-temperature phase of $(\text{NH}_4)_2\text{BeF}_4$ are reported here. A neutron analysis of the c-axis projection of a deuterated crystal was carried out, and the projection was refined first using difference maps and least-squares. The error index, with deuteriums included, dropped to 0.15. The subsequent Fourier synthesis indicated that the BeF_4 groups were either librating about the Be nuclei or systematically tilted in accordance with the superstructure. Assigning anisotropic temperature corrections to the F nuclei lowered the error index to 0.13, and reduced the standard deviations of the F coordinates by one-half.

1578

Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY STUDIES OF ABSOLUTE CONFIGURATIONS OF FERROELECTRIC CRYSTALS: II (Abstract), by F. Unterleitner, Y. Okaya and others. [1959] [3]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)35, Atomic Energy Commission, Office of Naval Research, and Signal Corps)

Unclassified

Presented at meeting of the Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

Recently a program for determination of the absolute configurations of certain ferroelectric transition structures has been initiated, in order to provide a more complete understanding of charge distributions and the physical mechanism of the spontaneous polarization and its field-reversibility. The absolute configurations of ferroelectric KD_2AsO_4 and $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$ are reported. The method used in these studies is that introduced by Okaya and Pepinsky, involving application of the $P_s(u)$ function. In the KD_2AsO_4 study, $\text{MoK}\alpha$ radiation was used to excite As, for which $f'' = 2.2$ electrons. The (h, k, l) intensities were measured, using a proportional counter, and the generalized projection $P_s^1(u, v) = \int_0^1 P_s(u, v, w) (\sin lw) dw$ was computed. The measure-

ments showed that the polarization occurs in the direction of the displacement of P within the PO_4 tetrahedra.

The phosphorus must carry the largest positive charge (about 3 or 4 times as great as that carried by K). This is directly in contradiction with the assumption of Bacon and Pease, who had assumed the polarization in the opposite direction. The absolute configuration of the ferroelectric phase of $(\text{glycine})_3 \cdot \text{H}_2\text{SO}_4$ was established, using $\text{CuK}\alpha$ to excite S in the SO_4 group; f'' for S is less than 0.5 electrons: It was established that the amino group of the glycinium ion near the plane $y = 1/4$ moves in the direction of the applied field. This substantiates the switching mechanism proposed by Hoshino et al. This is a remarkable illustration of the great power of the $P_s(u)$ function.

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Pennsylvania State U. [X-Ray and Crystal Analysis Lab.] University Park.

X-RAY STUDIES OF FERROELECTRIC AND SELENITES (Abstract), by K. Vedam, F. Unterleitner and others. [1959] 2p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)35], Atomic Energy Commission, Office of Naval Research, and Signal Corps)

Unclassified

Presented at meeting of Amer. Cryst. Assoc., Cornell U., Ithaca, N. Y., July 19-24, 1959.

$\text{NaH}_3(\text{SeO}_3)_2$ crystallizes in the monoclinic system with space group $P2_1/n$ and with cell dimensions $a = 10.36\text{A}$, $b = 4.84\text{A}$, $c = 5.80\text{A}$, $\beta = 91.2^\circ$, $Z = 2$. It exhibits a ferroelectric phase transition at -79°C , the low temperature phase being triclinic with space group Ci and the unit cell dimensions at -125°C being $a_L = 20.60\text{A} \approx 2a$, $b_L = 9.56\text{A} \approx 2b$, $c_L = 5.76 \approx c$, $\alpha_L = 89.8^\circ$, $\beta_L = 91.0^\circ$, $\gamma_L = 90.3^\circ$, $Z = 8$. The polar direction is along $[313]$ referred to the monoclinic axes. The structure analysis of the room-temperature phase of this crystal has been carried out following the usual procedure, using the $h\text{k}0$, $h0l$ and $0kl$ reflections for $\text{CuK}\alpha$ radiation. After least-squares refinement with the IBM 704, the R factor has been reduced to 0.10. The structure consists of sodium atoms in special positions $(0, 0, 1/2; 1/2, 1/2, 0)$ and pyramidal SeO_3 groups with Se-O distances 1.69A, 1.73A and 1.70A. The mean bond angle O-Se-O is 99.6° . The hydrogen bonds in this crystal form a 3-dimensional network interlinking the SeO_3 groups. In the latter crystal the SeO_3 groups are joined together by hydrogen bonds to form double layers parallel to (110) , the cleavage plane. No such cleavage plane could be detected in $\text{NaH}_3(\text{SeO}_3)_2$. A structure analysis of the low-temperature phase of this crystal is in progress. $\text{LiH}_3(\text{SeO}_3)_2$ also crystallizes in the monoclinic system,

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but with space group Pn and cell dimensions $a = 6.258\text{\AA}$, $b = 7.866\text{\AA}$, $c = 5.433\text{\AA}$, $\beta = 105.2^\circ$. This crystal exhibits ferroelectric properties at room temperature, and no phase transition could be detected in the temperature range -196°C to 110°C . A 3-dimensional structure analysis is in progress. (Contractor's abstract)

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Pennsylvania U., Philadelphia.

HE I GROUND-STATE WAVE FUNCTION OF THE FORM $\psi = f(r_1)f(r_2)g(r_{12})$, by L. C. Green, C. Stephens and others. [1959] [5]p. incl. tables, refs. (In cooperation with Haverford Coll., Strawbridge Observatory, Pa.) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)660], National Science Foundation, and Office of Naval Research)

Unclassified

Published in Jour. Chem. Phys., v. 30: 1061-1065, Apr. 1959.

A variational trial wave function of the form $\psi = f(r_1)f(r_2)g(r_{12})$ has been applied to the ground state of He I. In section I, $f(r)$ is taken to be an arbitrary function and $g(r_{12})$ is taken as linear. The form of $f(r)$ and the slope of $g(r_{12})$ are chosen to yield the minimum energy. The energy, $-5.79613R_{\text{He}}$ hc, and the form of f are compared with the results of earlier work and with the results obtained with analytic functions. A table of $f(r)$ and the charge distribution is given. The charge distribution is compared with that obtained from a Hartree-Fock wave function and the difference is discussed. In section II, $f(r)$ is taken as an exponential and $g(r_{12})$ is taken to be an arbitrary function. The coefficient in the exponent in $f(r)$ and the form of $g(r_{12})$ are chosen to yield the minimum energy. The energy, $-5.7852R_{\text{He}}$ hc, and the form f are compared with the results obtained with analytic wave functions. The behavior of g is shown in a table by its asymptotic series. The probable effectiveness of ψ if both $f(r)$ and $g(r_{12})$ are taken as arbitrary is discussed. (Contractor's abstract)

1581

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

[MATHEMATICS OF SMOOTHING OPERATORS], by I. J. Schoenberg. Final rept. Aug. 1959, 4p. incl. refs. (AFOSR-TR-59-112) (AF 18(600)1158)

Unclassified

This paper reviews the subject matter of the various reports issued under this contract. The difficulties

encountered are mentioned as well as the solutions used to overcome them. Mention is also made of the contributions made by visiting researchers.

1582

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

THE INTEGRABILITY OF CERTAIN FUNCTIONS AND RELATED SUMMABILITY METHODS, by I. J. Schoenberg. [1959] [15]p. incl. refs. [AF 18(600)1158] Unclassified

Published in Amer. Math. Monthly, v. 66: 361-375, May 1959.

Let γ_n , $1 < n < \infty$, be any sequence. Put $s_n = \sum_{d|n} \omega(d) \gamma_d / \sum_{d|n} \omega(d)$, where $\omega(n)$ is Euler's ϕ function. It

is shown that $\gamma_n \rightarrow \lambda$ implies $s_n \rightarrow \lambda$, but that the converse is not true. In fact, it is proven that $\lim s_n = \lambda$ implies $\gamma_{nv} \rightarrow \lambda$ if and only if $\liminf_{v \rightarrow \infty} \omega(n_v)/n_v > 0$. (Math.

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Pennsylvania U. [Dept. of Mathematics] Philadelphia.

ON A CONJECTURE CONCERNING SCHLICHT FUNCTIONS, by B. Epstein and I. J. Schoenberg. [1959] [3]p. [AF 18(600)1158] Unclassified

Published in Bull. Amer. Math. Soc., v. 65: 273-275, July 1959.

Let S be the class of all power series which converge and are univalent in the unit circle. It was conjectured that $\sum a_n z^n \in S$ and $\sum b_n z^n \in S$ implies $\sum n^{-1} a_n b_n z^n \in S$. This conjecture is disproved by the following counterexample. By a general result of Pólya and Schoenberg on de la Vallée-Poussin means (Pacific Jour. Math., v. 8: 295-334, 1958) the polynomial $P(z) = 15z + 12z^2 + 3z^3$ lies in S . This polynomial is composed with the general power series in S which can be obtained from Loewner's differential equation. The composition series is again a polynomial $p(z)$ of degree 3. By proper choice of the Loewner parameter function, one can achieve that $\hat{p}(z)$ vanishes in the unit circle. Thus, $p(z)$ cannot be univalent and a counterexample is constructed. (Math. Rev. abstract)

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Pennsylvania U. [Dept. of Mathematics] Philadelphia.

THE INTEGRABILITY OF CERTAIN FUNCTIONS AND

RELATED SUMMABILITY METHODS II. by I. J. Schoenberg. [1959] [2]p. [AF 18(600)1158]

Unclassified

Published in Amer. Math. Monthly, v. 66: 562-563, Aug.-Sept. 1959.

Three remarks to a previous paper (1582; The integrability of Certain Function etc., Vol. III) are made. A simple proof of Besicovitch is presented of the fact that to every δ there exists an n_0 so that for every $n > n_0$ each subinterval I_δ of length δ contains a fraction m/n , $(m, n) = 1$. (Math. Rev. abstract)

1585

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

[RISING ARCS WITH VANISHING SLOPES AND RELATED PROBLEMS] Sur les arcs ascendants à pente partout nulle et des problèmes qui s'y rattachent (Abstract), by A. S. Besicovitch and I. J. Schoenberg. [1959] [2]p. [AF 18(600)1158]

Unclassified

Published in Compt. Rend. Seances Acad. Sci., v. 246: 1079-1080, Sept. 28, 1959.

Let $x = i(t)$ be a Jordan arc in real Euclidean or Hilbert space E , and let $g(t)$ be a continuous function $0 < t < 1$.

If $\lim_{h \rightarrow 0} \frac{g(t+h) - g(t)}{f(t+h) - f(t)} = 0$ for all t , it follows that $g(t)$ is

constant if E is a line, and it is not a constant if E is Hilbert space or the plane. The latter conclusion results from the construction of a plane arc J with the property that to each $\epsilon > 0$ corresponds a constant C_ϵ

such that the plane measure of the subarc with extremities ν and ν' is positive and less than $C_\epsilon |\nu - \nu'|^{2-\epsilon}$.

This condition cannot be satisfied for $\epsilon = 0$. Two related results are: If $x = f(t)$ is a plane arc then \liminf

$\sum_{i=1}^n |f(t_i) - f(t_{i-1})|^2 = 0$, where the \liminf is taken over

all subdivisions $0 = t_0 < t_1 < \dots < t_n = 1$ as $\max |t_i -$

$t_{i-1}| \rightarrow 0$. A corollary is that $g(t)$ satisfies a Lipschitz

condition $|g(t) - g(t')| \leq C |f(t) - f(t')|^2$ then $g(t)$ is constant. (Math. Rev. abstract)

1586

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

ON THE MAXIMA OF CERTAIN HANKEL DETERMINANTS AND THE ZEROS OF THE CLASSICAL ORTHOGONAL POLYNOMIALS, by I. J. Schoenberg. [1959] [9]p. [AF 18(600)1158]

Unclassified

Published in Koninkl. Nederl. Akad. Wetensch. Proc., Indag. Math., Ser. A, v. 62: 282-290, 1959.

A proven proposition is generalized for $n = 2$ supposed by Neider, Hammersley and Ulins. If one places $l_v =$

$\int_0^\infty x v e^{-x} dF(x)$ with a positive measure $dF(x)$ in $(0, \infty)$

of total value 1, then the Hankel determinant of this integral (1) $D(F) = \det \|l_{i+j}\|_{i,j=0}^n$ $0, n \leq e^{-n(n+1)} (2^2 3^3 \dots$

$n^n)^2 = A_n (A_0 = 1)$, with an equality exact in the case,

where $dF(x)$ is simplified to $n+1$ points equal to the quantity $1/(n+1)$ equal to points (2) $x_0 = 0, x_i (i = 1, \dots, n)$

where x_i the zero points of Laguerre polynomials are

$L_n^{(1)}(x)$. The existence of a function $\eta(x)$ is proven which

assigns the greatest value $D(\eta)$ to the determinant (1).

Ulins train of thought is followed with the addition of 2

conditions necessary for a general n . The result of this

is that $\eta(x)$ possesses exactly $n+1$ points of increase $x_0,$

$x_i (i = 1, \dots, n)$, (2) $x_0 = 0 < x_1 < \dots < x_n$. With the help of

the function $f(s) = \int_0^\infty e^{-sx} dF(x)$, which takes on the value

$\sum_{v=0}^n A_v e^{-sx_v}$ for $F = \eta$ one finds $\Phi = \exp(-\sum_{i=1}^n x_i)$

$\prod_{i=1}^n x_i^2 \prod_{i>j}^n (x_i - x_j)^2, D(\eta) = A_0 A_1 \dots A_n \Phi$. The basis

of the study is a proposition demonstrable by means of a

theorem by Stieltjes: Φ just attains in (2) its maximum

value when x_i are the zero points of the Laguerre poly-

nomials $L_n^{(1)}(x)$. A more general theorem by the author

refers to the polynomial $L_n^{(\alpha)}(x)$, and he develops

ramifications of the theorem in the range $(-\infty, \infty)$ for

the Hermite polynomial, and in $(-1, 1)$, for Jacobian

polynomials, with the weights e^{-x^2} and $(1-x)^{\alpha+1}$

$(1-x)^{\alpha+1} (1+x)^{\beta+1}$ (instead of $x^{\alpha+1} e^{-x}$) in inte-

grands of I_v .

1587

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

ON VARIATION DIMINISHING APPROXIMATION METHODS, by I. J. Schoenberg. [1959] [26]p. incl. refs. [AF 18(600)1158]

Unclassified

Published in Proc. Symposium on Numerical Approximation, Wisconsin U., Madison (Apr. 21-23, 1958), Wisconsin U. Press, Madison, 1959, p. 249-274.

This report investigates approximations of a given function $f(x)$ by ordinary or trigonometric polynomials from the point of view of "variation-diminishing" operators in the special case where the approximation is generated by a linear functional operator. At first the important result is established that the approximation of $f(x)$ by Bernstein polynomials $B_n(x)$ is variation diminishing. This leads to some very explicit

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information about the behavior of this Bernstein approximation. If, for instance, $f(x)$ is convex (without being linear), then $B_n(x)$ is also convex and $B_n(x) > f(x)$.

Moreover, $B_{n-1}(x) > B_n(x)$ unless $f(x)$ is a polygonal line of special type. Analogous properties hold for the approximation of a periodic function $f(t)$ by the so-called de La Vallée Poussin means. Both methods of approximation avoid therefore unnecessary oscillations of the approximating functions. In the 2nd part of the paper, it is shown that "variation-diminishing" in the sense that it is defined, also leads under certain assumptions to a decrease of the total variation $T(f)$ of the given function. The result of Popoviciu $T(B_n) < T(f)$ is re-established, and it is shown that the equality sign holds in this relation if and only if $f(x)$ is monotone. In the last chapter variation-diminishing integral-operators of the convolution type and a wider class of "convexity-preserving" kernels are introduced. (Math. Rev. abstract)

1588

Pennsylvania U. [Dept. of Mathematics] Philadelphia.

FOURIER-STIELTJES SERIES OF WALSH FUNCTIONS, by N. J. Fine. [1957] [10]p. (AFOSR-5041) [AF 18(603)65] Unclassified

Also published in Trans. Amer. Math. Soc., v. 86: 246-255, Sept. 1957.

It is known that a trigonometric series is a Riemann-Stieltjes series if and only if its $(C, 1)$ sums are bounded in the L_1 norm. The analogous problem for the Walsh system needs a slight reformulation, since the Walsh functions are not continuous. Morgenthaler (Trans. Amer. Math. Soc., v. 84: 472-507, 1957) has proved that a Walsh series is a Riemann-Stieltjes corresponding to a continuous determining function of bounded variation if and only if

$$(1) \int_0^1 |\sigma_n(x)| dx = O(1) \text{ and } (2) \frac{S_n(x)}{n} \rightarrow 0 \text{ uniformly in}$$

$[0, 1]$, where S_n and σ_n are the partial sums and the $(C, 1)$ sums, respectively, of the given series. This still leaves open the general case, in which a Lebesgue-Stieltjes integral is used, the determining function being merely of bounded variation. It is the purpose of this paper to settle the question by giving necessary and sufficient conditions, and to show how the determining function may be recovered from the given series. It turns out that (1), which is necessary, is not sufficient. However, the analogy with the trigonometric case can be restored completely by transferring attention to the dyadic group, of which the Walsh functions are essentially the characters.

1589

[Pennsylvania U. Dept. of Mathematics, Philadelphia]

UNIVERSAL MINIMAL SETS, by R. Ellis. [1959] 4p. (AFOSR-TN-59-1119) (AF 49(638)569) AD 234511 Unclassified

Also published in Proc. Amer. Math. Soc., v. 11: 540-543, Aug. 1960.

Let T be an abstract group. Then a universal minimal set for T is a transformation group (X, T) with compact phase space X such that (X, T) is minimal and such that any other transformation group (Y, T) with Y compact and (X, T) minimal is a homeomorphic image of (X, T) . A universal minimal set is shown to exist for every group T and to be unique. The action of T on X is strongly effective. (Contractor's abstract)

1590

Pennsylvania U. [Dept. of Metallurgical Engineering] Philadelphia.

ON THE ROLE OF CONDENSED VACANCIES AND INTERSTITIALS IN FATIGUE, by R. K. McCrone and D. Kuhlmann-Wilsdorf. [1959] [2]p. (AFOSR-TN-59-705) (AF 49(638)435) AD 611384 Unclassified

Also published in Naturwissenschaften, v. 46: 334-335, 1959.

The phenomenon of extrusions and intrusions arising in the course of fatigue seems to be a key to the understanding of the mechanism of fatigue. In this paper the role of vacancies and interstitials in the formation of extrusions and intrusions is considered.

1591

Pennsylvania U. [Dept. of Physics] Philadelphia.

PHOTOPROTO.: SCINTILLATION SPECTROMETER, by A. Whetstone, B. Allison and others. [1958] [5]p. incl. diags. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)472] and Office of Naval Research) Unclassified

Published in Rev. Scient. Instruments, v. 29: 415-419, May 1958.

An apparatus is described for the measurement of the energy and angular distribution of protons from (γ, p) reactions. A method is presented for obtaining energy spread of 3% for protons of 3 to 15 mev with a NaI scintillator of 1-in. diam aperture. Energy calibration of the detector with monoenergetic protons gives an energy vs pulse-height line having an intercept of 0.46 ± 0.10 mev. The ratio of α particle to proton energy for equal pulse heights is found to be 1.93 ± 0.04 for 4.48 mev α particles. A CsI scintillator, similarly

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mounted, yields an intercept of -0.17 ± 0.15 mev and α -proton energy ratio of 1.66 ± 0.07 for 5.3-mev α particles. A modification of the phoswich to provide discrimination against electrons is described. (Contractor's abstract)

1592

Pennsylvania U. Dept. of Physics, Philadelphia.

STUDIES IN PHOTONUCLEAR REACTIONS. Annual rept. Oct. 15, 1958, 10p. incl. refs. (AFOSR-TR-59-189) (AF 18(600)472) AD 209806 Unclassified

A brief review of the research conducted under this contract is presented. The areas of interest include the betatron energy control system, the neutron detection system, the photoneutron thresholds, elastic scattering of photons, measurement of short half-life residuals, and neutrino-electron angular correlation in the β decay of ^6He . The methods used to accomplish better detection, more precise control, and more accurate measurements is discussed. The new method for precise energy control of a 25 mev betatron reportedly gives short term stability of better than ± 4 kev and long term stability of better than ± 15 kev. The results of the neutron detection system, which utilizes 3 BF^3 counters imbedded in a paraffin moderator with cadmium and Boro-paraffin shielding, shows the detection sensitivity to fall rapidly from threshold to about 100 kev above threshold and then displays a more gradual decline for about 1 mev. The results on photoneutron thresholds shows good agreement with previous results except in the case on oxygen which apparently has a photoneutron threshold of 190 ± 25 kev above the Q value (15.6). The state and progress of the research in the other mentioned fields is reported also but further experiments remain to be completed.

1593

Pennsylvania U. Dept. of Physics, Philadelphia.

THE INFLUENCE OF RADIATION INDUCED AND OTHER IMPERFECTIONS ON THE MECHANICAL, THERMAL AND OPTICAL PROPERTIES OF ALKALI HALIDE CRYSTALS, by B. R. Russell, P. H. Miller, Jr., and M. E. Caspari. Final rept. July 1959, 1v. incl. diagrs. table, refs. (AFOSR-TR-59-123) (AF 18(600)561) AD 230224; PB 144350 Unclassified

The thermal expansion of LiF single crystals were determined by macroscopic measurements and the x-ray determination of the lattice constant with temperature. The value obtained by the x-ray technique was 6% smaller than the macroscopic value. The generation of point imperfections and F-centers by weak ionizing irradiation, and the optical properties and the crystal dimensions were studied in Harshaw KCl and NaCl single crystals. A linear relationship existed between the relative linear expansion produced by a

certain dose of x-ray irradiation and the F-center concentration produced by that dose. The effect of annealing on the growth of the F-center curve was also determined. In a partially shielded crystal, vacancies were formed upon irradiation even in the shielded portion. Attempts to reproduce this effect by quenching annealing and fast cooling, annealing and slow cooling, and plastic deformation were unsuccessful. (Contractor's abstract)

1594

[Pennsylvania U. Dept. of Physics, Philadelphia]

THE DARKENING OF POTASSIUM CHLORIDE CRYSTAL BY X-RAYS, by C.-Y. Sheng. [1959] [19]p. incl. diagrs. (Bound with its AFOSR-TR-59-123; AD 230224; PB 144350, as appendix I) [AF 18(600)561] Unclassified

X-ray irradiated single crystals of KCl were examined spectrophotometrically, in order to study the darkening, i.e., the formation of color centers in alkali halide when irradiated by x-rays. To a first approximation, the density of F-centers produced by x-rays was found to be proportional to x-ray intensity and time of irradiation; the stronger the x-rays and the longer the irradiation time, the larger the density. The darkenability varied from crystal to crystal, and over various portions of the same crystal. Observations showed that annealed crystals treated with x-rays have a higher density of F-centers than "as-received" crystals under identical conditions. It was also noted that when subsequent halves of a crystal were irradiated while shielding the adjacent half, the last irradiated portion always showed a higher F-center density than the initially irradiated part. This phenomena could not be explained. The problem of bleaching during measuring is discussed.

1595

[Pennsylvania U. Dept. of Physics, Philadelphia]

THE F-CENTER DENSITY IN PARTIALLY IRRADIATED POTASSIUM CHLORIDE CRYSTALS, by P. D. Howley. [1959] [17]p. incl. diagrs. table, refs. (Bound with its AFOSR-TR-59-123; AD 230224; PB 144350, as appendix II) [AF 18(600)561] Unclassified

Two aspects of L. Y. Lin's work on NaCl and KCl crystals (Phys. Rev., v. 102: 968, 1956) are investigated; namely the fractional irradiation of the crystal, and the irradiation of successive halves of the crystal. In particular, an attempt was made to determine whether the results observed were due to some particular state of imperfection present in Lin's crystal. The F-center density was found to be independent of the fractional surface area irradiated, and there was no increase in the F-center density as a result of previous irradiation of an adjacent part of the crystal, as

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reported by Lin. Evidence is cited, however, to support the theory that this effect may occur in crystals of a purer state than those used in the present experiment.

1596

Pennsylvania U. Dept. of Physics, Philadelphia.

STUDIES IN PHOTONUCLEAR REACTIONS. Annual rept. Oct. 15, 1959, 14p. incl. tables, refs. (AFOSR-TN-59-1211) (AF 49(638)454) AD 228406

Unclassified

A brief review is given of the investigations carried out to date under this project. The new betatron control system was calibrated using thresholds for photoneutrons from deuterium, bismuth, copper and for the isochromat from the 15.12 mev level in carbon. A total of 73 photoneutron thresholds were measured throughout the periodic table with an average accuracy of the order of 50 kev. In some instances the observed photoneutron threshold did not correspond to the neutron binding energy for the initial nucleus. The apparent threshold represents either (1) resonant photon absorption at an energy slightly greater than the kinematic threshold energy, or (2) neutron emission leaving the residual nucleus in an excited state having a more favorable spin. The activation curves for carbon, nitrogen, oxygen and fluorine were analyzed to yield the (γ, n) cross section in the neighborhood of threshold. Activation curves measured for carbon and oxygen show fine structure in good agreement with the known level schemes. Cross section analysis using the measured isochromat to generate the photon spectrum is presently in progress. Preliminary results indicate that these levels are wider than previously obtained from "break" data alone.

1597

Pennsylvania U. [Dept. of Physics] Philadelphia.

PHOTONEUTRON THRESHOLD MEASUREMENTS (Abstract), by K. N. Geller, E. G. Muirhead, and J. Halpern. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)454] and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 32, Jan. 28, 1959.

Photoneutron thresholds of 45 mono- and di-isotopic elements have been measured using our 25-mev betatron with improved energy stability. Neutron yields in the vicinity of threshold were measured in steps of approximately 25 kev. Thresholds were obtained by extrapolating the direct yield curve into the measured background. Other methods of extrapolation were used to refine this crude value. For most elements neu-

trons were detected directly by using three BF_3 counters embedded in a paraffin block. For light elements, greatly improved sensitivity was obtained by measuring the annihilation radiation from the residual positron activity with two NaI(Tl) crystals. The primary energy calibration of the betatron is based on the thresholds of the (γ, n) reaction in D (2.226 mev), Bi^{209} (7.43 mev), Cu^{63} (10.83 mev), P^{31} (12.33 mev), and of elastic scattering of the photon isochromat by the 15.11-mev level in C^{12} . The final energy calibration includes many other photoneutron thresholds as secondary standards. The energy scale so obtained is linear on an electron momentum versus "dekavider" setting plot to within the accuracy of measurements (± 25 kev in the range 2-20 mev). Comparison of the present results with other threshold measurements and with recent mass data will be made.

1598

Pennsylvania U. [Dept. of Physics] Philadelphia.

ENERGY LEVEL PARAMETERS FROM NUCLEAR RESONANCE FLUORESCENCE AT 7 MEV, by K. Reibel and A. K. Mann. [1959] [54]p. incl. diagrs. tables. refs. (AFOSR-TN-59-1203) (AF 49(638)537)

Unclassified

Also published in Phys. Rev., v. 118: 701-713, May 1, 1960.

The recoil broadened photon spectrum from the reaction $\text{F}^{19}(\text{p}, \alpha \gamma) \text{O}^{16}$ has been used to measure the elastic photon scattering cross sections at 7 mev of 31 elements. The observed angular distributions are consistent with dipole transitions. A plot of the cross sections versus mass number shows definite peaks around the closed shell regions near $Z = 50$, $N = 82$ (Sn, Te and Ba), and $Z = 82$, $N = 126$ (Pb and Bi). For 6 medium and heavy elements self absorption measurements were made which, when analyzed in terms of a number of non-overlapping Breit-Wigner resonances, yield values of the average partial radiation widths to the ground states, the average total radiation widths, and the average level spacings for those elements. The radiation widths are significantly larger than those determined from slow neutron scattering and capture experiments and, excepting Pb and Bi , the average level spacings are also appreciably greater than would be expected from the neutron data. The observed widths and spacings are in order of magnitude agreement with the recent interpretation of the modified single particle calculation of Blatt and Weisskopf. (Contractor's abstract)

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1599

Pennsylvania U. Inst. for Cooperative Research,
Philadelphia.

A NOTE ON THE POSSIBILITY OF A DIVIDED STRUCTURE FILE PERMITTING ARBITRARY SUBSTRUCTURE SEARCHES, by J. O'Connor. [1959] [14]p. (Sponsored jointly by Air Force Office of Scientific Research and Office of Naval Research under [Nonr-55135]) AD 243354 Unclassified

Given a file of structures S_1, \dots, S_N and an arbitrary question structure Q , to find which S_i 's include Q as a substructure. Organic molecule structures provide an example of this problem. The problem can be solved by comparing Q with all NS_i 's. However, the question arises as to whether the following approach can be used: divide the file, with duplicate storage entries for S_i 's, so that (1) the search for any Q need examine at most K file structures, with K some fraction of N ; (2) the average number of storage entries per S_i is $\leq D$; and (3) at most Z headings have to be compared with Q to determine which part of the file to search. Attention is confined to those Q 's which are included in at least one and no more than M file structures. Among these Q 's are some, B_1, \dots, B_r , which form an included basis for the rest, in that any other Q includes at least one B_k . (Contractor's abstract)

1600

Phillips Petroleum Co., Bartlesville, Okla.

A CALORIMETRIC STUDY OF TRAPPED RADICALS PRODUCED BY GAMMA RADIATION, by R. L. Arnett, E. D. Guth, and J. R. Berreth. Sept. 1959 [46]p. Incl. diagrs., refs. (Research Div. rept. no. 2574-60R) (AFOSR-TN-59-894) (AF 49(638)45) AD 235427; PB 149002 Unclassified

Presented at Fourth Internat'l. Symposium on Free Radical Stabilization, Nat'l. Bur. Standards, Washington, D. C., Sept. 1959.

Several pure gases in the crystalline state (ammonia, methane, nitrogen, argon) and a glass of ammonia, water, acetone, have been irradiated in a gamma field. The amounts of energy stored in the solids are determined by calorimetry. A description is given of the calorimeter and experimental techniques. The energy stored amounts to a few joules/g (up to 12 in 1 experiment with methane) and represents only 2 to 5% of the gamma energy absorbed. From comparison of these results with those obtained by condensing an electrodeless discharge gas, it is suggested that the trapped energy carriers are in their ground state when generated by gamma radiation of solids and at least some are trapped in excited states when condensed from a discharged gas. (Contractor's abstract)

1601

Phillips Petroleum Co., Bartlesville, Okla.

CHEMICALLY REACTIVE SPECIES. THEIR PRODUCTION, STABILIZATION, CONCENTRATION AND STORAGE, by R. L. Arnett, E. D. Guth, and J. R. Berreth. Final rept. Oct. 1959 [39]p. Incl. illus., diagrs., tables, refs. (Research Div. rept. no. 2478-59R) (AFOSR-TR-59-190) (AF 49(638)45) AD 235428; PB 150072 Unclassified

The continual search for higher energy propulsive fuels has fostered research on the generation and stabilization of free radicals. This investigation (for which this is the final report) is part of the general military sponsored program aimed at determining the feasibility of making such a fuel, and is specifically concerned with direct determinations of the energy stored in various free radical containing systems. The radicals are generated *in situ* in solids by gamma irradiation. The solids are condensed low molecular weight gases; e.g., ammonia, methane, nitrogen. The energy stored in these systems is measured by direct calorimetric observations of the apparent heat capacity of the irradiated material as compared to that for the unirradiated material. The apparatus for making these measurements is described and a summary discussion of the results is given. No 'fuel-level' concentration of stored energy was approached in any experiment - this level being 10,000 times greater than any found. A low efficiency (3 - 4%) for the trapping process is a general feature of the results with a decrease in this efficiency as the level of stored energy increases. Curves are given showing the energy released as the solid is warmed for each system examined.

1602

Pisa U. Inst. of Aeronautics (Italy).

THE AERODYNAMICS OF AIRFOILS IN NON-UNIFORM STREAMS OF INCOMPRESSIBLE FLUID, by E. Pistolesi and M. Marini. [1959] [18]p. Incl. diagrs. (Technical note no. 1) (AFOSR-TN-59-111) (AF 61-514)1051 AD 210391; PB 140150 Unclassified

An aerodynamic study was conducted on an airfoil immersed in a bidimensional stream of incompressible perfect fluid, adjacent to another bidimensional stream of incompressible perfect fluid having a different velocity. The interface between the 2 streams is constituted by a rigid wall, from infinity upstream to a point situated at a finite distance from the airfoil. An uncambered airfoil of zero thickness, is disposed at a small angle of attack in the stream. The vortex in the aerodynamic center of the airfoil has a strength equal to the total circulation existing around the airfoil. The aerodynamic effects on the airfoil are determined as a first approximation in conformal mapping. The same problem may also be solved without conformal mapping by adopting convenient functions for the complex velocity which satisfy the condition of no flow at the rigid wall.

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1603

Pisa U. Inst. of Aeronautics (Italy).

THE AERODYNAMICS OF AIRFOILS IN NON-UNIFORM STREAMS: SUBSONIC AND SUPERSONIC STREAMS, by E. Pistolesi and M. Marini. [1959] [19]p. incl. diagrs. tables. (Technical note no. 2) (AFOSR-TN-59-112) (AF 61(514)1051) AD 210392; PB 140149
Unclassified

The aerodynamic characteristics are studied of an airfoil situated in a subsonic stream adjacent to a supersonic stream. The supersonic stream is constituted of a stream of finite width bounded at the lower side by a rigid wall or constituted of a jet of finite width. Convenient hypotheses were adopted to facilitate study by means of linearized theory. After calculating the values of the velocities induced in the aerodynamic center of the airfoil, the values of the ratios between the real values of the circulation and of the lift, and the corresponding values for an airfoil in a uniform stream were deduced.

1604

Pisa U. Inst. of Aeronautics (Italy).

THE AERODYNAMICS OF AIRFOILS IN NON-UNIFORM SUPERSONIC STREAMS, by E. Pistolesi and M. Marini. [1959] [43]p. incl. diagrs. tables. (Technical note no. 3) (AFOSR-TN-59-113) (AF 61-514)1051) AD 210393; PB 140147
Unclassified

The aim of the present research is the study of the aerodynamic characteristics of an airfoil situated in a bidimensional supersonic stream (1) adjacent to another bidimensional supersonic stream (2) having different velocity. The research has been accomplished adopting the small perturbation theory; the airfoil has been supposed to be a flat plate disposed at a small angle of attack in the stream (1). All the compression and expansion waves have been supposed weak and such as to be represented by means of Mach waves.

1605

Pisa U. Inst. of Physiology (Italy).

EFFECT OF UNILATERAL CHRONIC LESIONS OF THE MIDBRAIN ON THE ELECTROCORTICAL ACTIVITY OF THE CAT, by J. P. Cordeau and M. Mancini. [1959] [26]p. incl. diagrs. refs. (AFOSR-TN-59-117) (AF 61(514)1125) AD 210422
Unclassified

Also published in Arch. Ital. Biol., v. 96: 374-399, 1958.

A complete hemisection of the midbrain at the superior collicular level produces a striking asymmetry in the electrocortical activity of the cat's brain. The ipsilateral hemisphere shows nearly continuous synchronized activity, while the contralateral side shows the

usual EEG variations in line with the behavior of the animal. It is concluded from this observation that the ascending reticular system separates into 2 distinct streams, one for each hemisphere, at the mesencephalic level. However, activating impulses can still cross from the normal half of the brain stem, rostrally to the level of the section. The asymmetry recorded after a mesencephalic hemisection is at its greatest immediately after the operation, fading gradually until its complete disappearance some 5-8 days post-operatively. From various combinations of unilateral partial lesions of the midbrain tegmentum at the superior collicular level in the normal cat and in the midpontine pretrigeminal cat, it was concluded that the destruction of the medial and lateral parts of the reticular formation as well as the section of the lateral specific sensory pathways contribute to the ipsilateral synchronization produced by the complete hemisection.

1306

Pisa U. Inst. of Physiology (Italy).

[ELECTROENCEPHALOGRAPH AND BEHAVIOR AFTER CHRONIC LESIONS OF THE RETICULAR SUBSTANCE AND OF THE WAYS OF SPECIFIC SENSIBILITY] Elettroencefalogramma e comportamento dopo lesioni croniche della sostanza reticolare e delle vie della sensibilità specifica, by G. F. Rossi. [1957] [21]p. incl. diagrs. refs. (AFOSR-TN-59-386) (AF 61(514)1125)
Unclassified

Also published in Atti Convengo Parma, Nov. 23-24, 1957, p. 131-151.

The sight is due to the activity of the ascendent reticular system according to most sources. This is questioned on the basis of the demonstration given of the experimental anatomy of a system of sensitive fibers ascending along the medial part of the mesencephalic trunk, topographically placid near the reticular system and terminating in the aspecific diencephalic structure. It is concluded experimentally that the impulses that keep the superior centers active in the pretrigeminal midpontine preparation with the afferent receptors removed, are developed from an ascendent reticular system whose function is explained by the influx of sensitive afferents. The reticular substance seems capable of an autochthonous activity and the sustaining electroencephalographic rhythms of high frequency and low amplitude that characterize sight.

1607

Pisa U. Inst. of Physiology (Italy).

[RECENT CONTRIBUTIONS TO THE PHYSIOLOGY OF SLEEP] Recenti contributi alla fisiologia del sonno, by G. Moruzzi, G. F. Rossi, and A. Zanchetti. [1958] [12]p. incl. diagrs. refs. (AFOSR-TN-59-387) (AF 61-514)1125)
Unclassified

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Also published in Atti Soc. Lombarda Sci. Med. Biol., Suppl., v. 13: 1-12, 1958.

Various data and experiments related to studies of the physiology of sleep are presented. The reaction of electroencephalographic arousal produced by a short whistle in the non-anaesthetized whole cat is shown. A schematic representation is given of the anatomical and electroencephalographic characteristics of the prepared "isolated encephalon" and "isolated cerebellum". According to Bremer's original hypothesis, wakefulness in the first preparation and sleep in the second would be owed to the action and respectively to the suppression of the centripetal impulses carried from sensitive paths (in black in the anatomical scheme shown). The topography and extent of the reticular substance in the encephalic trunk in the cat are shown. An anatomical functional schematic representation of the ascending reticular system and of the paths of specific sensitivity is shown. A diagram shows the levels figured from the trunk of the cats encephalon for the transversal pretrigeminal mediodorsal and rostromedial sections. Several related experiments are summarized.

1608

Pisa U. Inst. of Physiology (Italy).

[SPONTANEOUS ELECTRICAL ACTIVITY OF THE PIGEON'S OPTIC LOBES] Attività elettrica spontanea dei lobi ottici del piccione, by A. Borrazzo and A. Mollica. [1958] [2]p. incl. refs. (AFOSR-TN-59-419) (AF 51(514)1125) Unclassified

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1029-1030, 1958.

The study is made of spontaneous physiological electrical activity and its mechanisms. The electrical activity of the optic lobes is registered in the pigeon's thalamus far from the narcotic, either in the surface by means of bipolar or unipolar macroelectrodes of cotton, or deeply by means of fluctuating unipolar microelectrodes, of platinum or steel, 25-37 μ in cross section. The results obtained are: (1) spontaneous electrical activity showing a series of small rapid potential oscillations of elevated frequency; (2) such activity is not appreciably modified by either illumination of the surroundings or by the introduction of curare (Sincurarina) at paralyzing dosages; (3) the suppression of the retinal afference of an optic lobe produces a net and persistent amplitude reduction of the spontaneous electrical activity; (4) a persistent depression of the spontaneous electrical activity without any trace of synchronization is observed in the decerebrated and bilaterally blinded pigeon; (5) such states are produced by parenteral introduction of barbiturates; and (6) the local application of strychnine causes typical convulsive phenomena (clonus) of the contralateral musculature. Different spontaneous electrical activity phenomena in the pigeon varying from mammals are found to be in the absence of physiological, pharmacological and convulsive synchronization phenomena.

1609

Pisa U. Inst. of Physiology (Italy).

[ELECTROPHYSIOLOGICAL ANALYSIS OF THE INTERACTION PHENOMENA BETWEEN THE OPTIC LOBES OF THE DECEREBRATED PIGEON] Analisi elettrofisiologica dei fenomeni di interazione fra i lobi ottici del piccione decerebrato, by A. Borrazzo and A. Mollica. [1958] [2]p. incl. refs. (AFOSR-TN-59-420) (AF 61(514)1125) Unclassified

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1031-1032, 1958.

Researches investigate this interaction between the optical systems of the 2 sides, recording with unipolar or bipolar method, the surface response of an optic lobe to short light stimulations applied to the contralateral eye at the rate of 1/sec. An acutely decerebrated pigeon is used which is completely curarized and artificially ventilated. The following results have been obtained: (1) the surface responses of the surface of an optic lobe to a short luminous stimulus applied to the contralateral eye is complex; (2) for the homolateral eye on the optic lobe constantly increasing electrical activity is registered after emulsion, cocaine treatment or an opaque filter; (3) if the homolateral eye is illuminated by a white light and the contralateral eye regular light, the electric responses of the lobe appear depressed; (4) the application of a solution of a 0.2-0.5% strychnine sulfate to an optic lobe causes a decrease in the amplitude of the electrical response of the contralateral optical lobe; (5) the application of 1% cocaine chlorohydrate to an optic lobe causes an increase in the electrical responses of the contralateral optic lobe. The activity of one side of the optic system is seen to reduce or inhibit the activity of the other side.

1610

Pisa U. Inst. of Physiology (Italy).

EFFECTS OF COMPLETE PONTINE TRANSECTIONS ON THE SLEEP-WAKEFULNESS RHYTHM: THE MIDPONTINE PRETRIGEMINAL PREPARATION, by C. Batini, G. Moruzzi and others. [1959] [12]p. incl. diagrs. refs. (AFOSR-TN-59-447) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) AD 214809 Unclassified

Also published in Arch. Ital. Biol., v. 97: 1-12, 1959.

Complete pontine transections were performed electrolytically in cats with implanted electrodes in the skull, and the EEG and ocular behavior of these animals were followed up to 9 days. Transections performed through the middle pons, just in front of the trigeminal rootlets (midpontine pretrigeminal preparations), brought about low voltage fast EEG rhythms and ocular behavior suggestive of wakefulness. The EEG and eye signs of wakefulness were strikingly more persistent during the

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survival time (up to 9 days) of these preparations than in normal intact cats. The sleep-wakefulness balance was definitely shifted toward a state of prolonged vigilance. Transections performed through the upper pons (rostromedullary pretrigeminal preparations) induced high voltage slow EEG rhythms and ocular patterns of sleep, which remained unmodified throughout the entire survival period (up to 6 days). Since the rostromedullary and the midpontine preparations are both connected to sensory receptors through the first 2 pairs of cranial nerves only, the trigeminal sensory input being thoroughly eliminated in both, the different EEG and behavioral patterns of the 2 preparations can be related to the injury or to the integrity of a small amount of nervous tissue lying in the rostral part of the pons. (Contractor's abstract)

1611

Pisa U. Inst. of Physiology (Italy).

NEURAL MECHANISMS UNDERLYING THE ENDURING EEG AND BEHAVIORAL ACTIVATION IN THE MIDPONTINE PRETRIGEMINAL CAT, by C. Batini, F. Magni and others. [1959] [13]p. incl. diagrs. table, refs. (AFOSR-TN-59-448) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) AD 214772
Unclassified

Also published in Arch. Ital. Biol., v. 97: 13-25, 1959.

The observation by Roger, Rossi and Zironi that the gasserectomized "encéphale isolé" cat displays high voltage slow waves was confirmed, and the synchronized electrocortical activity was found to be independent of low arterial pressure or excessive ventilation. The enduring EEG and behavioral patterns of wakefulness characteristic of the midpontine pretrigeminal preparation are changed into those typical of sleep by a subsequent brain stem transection performed at rostromedullary levels. This experiment and other data reported in the text indicate that the irritation of activating reticular structures lying just in front of the midpontine lesion cannot be held responsible for the occurrence of low voltage fast activity in this preparation. Other control experiments show that the persistent patterns of wakefulness are not due to increase of adrenaline discharge or arterial carbon dioxide tension. The existence and the nature of an EEG synchronizing influence originating in the lower brain stem are discussed. (Contractor's abstract)

1612

Pisa U. Inst. of Physiology (Italy).

EEG AROUSAL FOLLOWING INACTIVATION OF THE LOWER BRAIN STEM BY SELECTIVE INJECTION OF BARBITURATE INTO THE VERTEBRAL CIRCULATION, by F. Magni, G. Moruzzi and others. [1959] [14]p. incl. diagrs. refs. (AFOSR-TN-59-449) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) AD 214771
Unclassified

sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) AD 214771
Unclassified

Also published in Arch. Ital. Biol., v. 97: 33-46, 1959.

Clamping of the basilar artery and adequate cannulation of the lingual and subclavian arteries have permitted selective introduction of a barbiturate, thiopental sodium, into the vascular circuits separately supplying either the rostral pons, midbrain and upper cerebrum, or the medulla and caudal pons. Intracarotid injections of small amounts (0.1-0.6 mg) of thiopental sodium induced a short lasting synchronization of the electrocortical activity in the "encéphale isolé" animal. Slight doses affected ipsilateral cortical activity only, while repeated injections or larger doses produced bilateral synchronization. Intravertebral introduction of equally small amounts (0.3-0.6 mg) of thiopental sodium invariably and reversibly elicited opposite effects, i.e. EEG arousal reaction, provided that the electrocortical activity of the "encéphale isolé" animal displayed synchronized patterns. Thiopental doses as low as 0.1 mg, introduced into the vertebral circulation, proved to be capable of abolishing reflexes normally very resistant to anesthesia, such as the corneal reflex. The EEG arousal following intravertebral injection of thiopental is interpreted to be due to a functional transient inactivation of a synchronizing influence originating in the lower brain stem. (Contractor's abstract)

1613

Pisa U. Inst. of Physiology (Italy).

[EFFECTS OF UNILATERAL MESENCEPHALIC AND PONTINE SECTIONS ON THE ELECTROENCEPHALOGRAM] Effetti di sezioni unilaterali mesencefaliche e pontine sull'elettroencefalogramma, by J. P. Cordeau and M. Mancini. [1959] 12p. (AFOSR-TN-59-465) [AF 61(514)1125] AD 215270
Unclassified

Also published in Ricerca Scient., v. 29: 512-516, Mar. 1959.

A mesencephalic hemisection of the cat's brain is followed by EEG asymmetry. The hemisphere ipsilateral to the section is synchronized while the other is in line with the behavior of the animal. A midpontine hemisection yields a different kind of EEG asymmetry: it is characterized by a greater tendency to synchronization in the contralateral cerebral hemisphere. The possible interpretation of these results is briefly discussed.

1614

Pisa U. Inst. of Physiology (Italy).

EEG ACTIVATION PATTERNS IN THE MIDPONTINE PRETRIGEMINAL CAT FOLLOWING SENSORY

AIR FORCE SCIENTIFIC RESEARCH

DEAFFERENTATION, by C. Batini, M. Palestini and others. [1959] [7]p. incl. diagr. (AFOSR-TN-59-780) (AF 61(514)1125) AD 225182 Unclassified

Also published in Arch. Ital. Biol., v. 97: 26-32, 1959.

Combined olfactory and visual deafferentation immediately change the waking EEG patterns of the midpontine pretrigeminal preparation into those typical of sleep. However, with the passage of time, EEG patterns of sleep gradually wane, finally giving way, 1-2 days from the completion of sensory deafferentation, to the previous low voltage fast EEG rhythms. It is concluded that in the midpontine pretrigeminal preparation EEG activation patterns are independent on the sensory inflow. (Contractor's abstract)

1615

Pisa U. Inst. of Physiology (Italy).

[EFFECTS ON THE RETINA INDUCED BY CHEMICAL STIMULATION OF THE OPTIC LOBE] Effetti centrifughi retinici indotti dalla stimolazione chimica dei lobi ottici, by A. Borrazzo and A. Mollica. [1958] [2]p. incl. refs. (AFOSR-TN-59-827) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology, Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1681-1682, 1958.

The study is made of the influence of the optic lobes of birds on the retinal activity shown by the electroretinogram. The experiments were carried out on decerebrated pigeons, completely immobilized and artificially ventilated. The nature of the electroretinogram wave is studied for the behavior of the small polyphase superimposed on the peak of the wave, which registered the simultaneous discharge of various centripetal fibers of the optic nerve.

1616

Pisa U. Inst. of Physiology (Italy).

[THE ELECTROENCEPHALOGRAM OF THE PIGEON] L'Elettroencefalogramma del piccione, by A. Mollica and M. Orsini. [1958] [2]p. incl. refs. (AFOSR-TN-59-828) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology, Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1683-1684, 1958.

Experiments carried out on the electrophysiological analysis of the spontaneous or evoked electrical activity of the cerebral hemisphere of birds are discussed. The subject is immobilized in a way which excludes interference of the electrical potential of muscular origin. The existence of a slow rest rhythm and of a working electroencephalographic reaction is found in birds in a hypnotic state. However, a sleep cannot be induced by barbiturates in birds with an electroencephalogram compared to mammals. The cause is ascribed to the anatomical structure of the telencephalon of birds in which a true and proper cerebral cortex is missing.

1617

Pisa U. Inst. of Physiology (Italy).

[MODIFICATIONS IN THE ELECTROENCEPHALOGRAM AFTER CHRONIC UNILATERAL LESIONS IN THE MESENCEPHALON OF THE CAT] Modificazioni elettroencefalografiche per emilezioni croniche del mesencefalo nel gatto, by J. P. Cordeau and E. Mancina. [1958] [2]p. (AFOSR-TN-59-829) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology, Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1690-1691, 1958.

The purpose of this report is to study the reticulo-cortical connections by means of unilateral chronic lesions in the mesencephalon. The experimental data confirms the anatomical and physiological observations, at the mesencephalic level of the reticulo-cortical paths that exercise an activating effect in each hemisphere. The electroencephalographic asymmetry is less intense and more rapidly compensated for after a complete pretrigeminal midpontine section. This last observation could be compared with the hypothesis of a major tendency for the activation of the midpontine preparation through the suppression of the synchronizing action by the central part situated in the caudal parts of the encephalic trunk.

1618

Pisa U. Inst. of Physiology (Italy).

[EXPERIMENTAL EVIDENCE IN FAVOR OF THE EXISTENCE OF A STRUCTURE SYNCHRONIZING THE ELECTROENCEPHALOGRAM IN THE CAUDAL PARTS OF THE BRAIN STEM] Prove sperimentali in favore dell'esistenza di strutture sincronizzanti l'elettroencefalogramma nelle parti caudali del tronco dell'encefalo, by J. P. Cordeau and M. Mancina. [1958] [2]p.

AIR FORCE SCIENTIFIC RESEARCH

(AFOSR-TN-59-830) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Presented at the Twenty-seventh General Assembly of the Ital. Soc. of Experimental Biology, Milan (Italy), Oct. 2-4, 1958.

Also published in Boll. Soc. Ital. Biol. Sper., v. 34: 1691-1692, 1958.

The hypothesis is tested that the electroencephalographic asymmetry, produced by the unilateral action of the mesencephalon is less intense and more rapidly compensated for in the pretrigeminal mediopontine preparation. It is believed that the electroencephalographic desynchronization that is seen at the ipsilateral cerebral hemisphere may be due to the interruption of synchronizing paths emanating more caudally and is not, in fact, "irritative" to the change of the activating structure placed rostrally to the section. The evidence supports the hypothesis of the existence of inhibitory or synchronizing mechanisms operating on the cerebral cortex, localized in the caudal part of the encephalic trunk.

1618

Pisa U. [Inst. of Physiology] (Italy).

[CEREBRAL STUDIES ON THE ORIGIN OF THE SYNDROME OF PERSISTANT WAKEFULNESS IN THE MEDIOPONTINE PREPARATION. EVIDENCE FAVORING THE EXISTENCE OF AN INFLUENCE OF BULBOPONTINE STRUCTURES ON THE ELECTRICAL ACTIVITY OF THE BRAIN] *Ricerca sull'origine della persistente sindrome di veglia del preparato mediopontino. Dati a favore dell'esistenza di una influenza sincronizzante di strutture bulbo-pontine sull'attività elettrica cerebrale*, by C. Batini, F. Magni and others. [1959] [4]p. (AFOSR-TN-59-831) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Also published in Riv. Neurol., v. 29: 126-129, Mar.-Apr. 1959.

The experimental observations made show that a sleep of long duration in the encephalically isolated cat occurs when an electroencephalographic and ocular syndrome of insomnia is present. These animals must be subjected to a complete transversal sectioning of the encephalic trunk at the level of the medial part of the pons, immediately in front of the trigeminal nerve. The existence of an influence synchronizing the cortical electrical activity, perhaps of a hypnogenic nature, originating from the caudal part of the encephalic trunk, is analyzed.

1620

Pisa U. [Inst. of Physiology] (Italy)

[SYNCHRONIZING INFLUENCES ON THE ELECTROENCEPHALOGRAPH AND THEIR ORIGIN IN THE CAUDAL PARTS ON THE BRAIN STEM] *Influenze sincronizzanti l'elettroencefalogramma e loro origine nelle parti caudali del tronco dell'encefalo*, by J. P. Cordeau and M. Mancini. [1959] [3]p. (AFOSR-TN-59-832) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125 and Rockefeller Foundation) Unclassified

Also published in Riv. Neurol., v. 29: 132-134, Mar.-Apr. 1959.

An investigation is given of the study of electroencephalographic effects of unilateral mediopontine sectioning. The unilateral sectioning of the pons interrupts ascendant paths, from the appropriate side, of the structure situated more caudally and those provided with a synchronizing action on the ipsilateral hemisphere. Such interruption causes an activation of the trace limited to the ipsilateral hemisphere. In communications with the opposite side, synchronizing impulses can freely exercise their action on the hemisphere from the same side across the intact half of the encephalic trunk. The electroencephalographic effects of unilateral midpontine sections regarding the action mechanism could act directly by synchronizing the cortical neurons, inhibiting the ascending reticular system, or facilitating the activity of the thalamic pacemakers.

1621

Pisa U. Inst. of Physiology (Italy).

[ROLE OF THE ASCENDING RETICULAR SYSTEM IN SENSORY INTEGRATION] *Rôle du système réticulaire ascendant dans l'intégration sensorielle*, by G. Moruzzi. Oct. 1958 [32]p. incl. refs. (AFOSR-TN-59-970) (AF 61(514)1125) Unclassified

The reticular system is considered as a regulatory system and as a support of the excitation level, contributing through that indirectly to sensory integration. The studies discussed suggest the existence, in the most caudal parts of the encephalic trunk, of structures which have an action antagonistic to that of the activating reticular system, since these tend to synchronize the electric pulsations of the cortical neurons. The lesions of the encephalic trunk of the cats tested were made by the stereotaxic method and their tension was controlled histologically.

1622

Pisa U. Inst. of Physiology (Italy).

SYNCHRONIZING INFLUENCES OF THE BRAIN STEM AND THE INHIBITORY MECHANISMS UNDERLYING

AIR FORCE SCIENTIFIC RESEARCH

THE PRODUCTION OF SLEEP BY SENSORY STIMULATION, by G. Moruzzi. [1959] [26]p. incl. diagrs. (AFOSR-TN-59-971) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)1125, and Rockefeller Foundation) AD 226323 Unclassified

Presented at Internat'l. Colloq. on the Electroencephalographic Study of the Higher Nervous Activity Processes in Animals and Man, Moscow, 1958.

Experiments show that EEG and ocular patterns of wakefulness are present in the cat after midpontine pretrigeminal transection; however, EEG and ocular patterns of sleep occur when the brain stem is transected a few mm rostrally. There is possibly a region in the rostral part of the pons and caudalmost part of the midbrain which is critical to EEG patterns of wakefulness. It is proposed that the entire reticular formation of the midbrain, sustained by tonic sensory impulses, is not sufficient to preserve an alert state. The upper part of the pons must at least remain connected to the midbrain to maintain EEG activation. (Contractor's abstract, modified)

1623

Pisa U. Inst. of Physiology (Italy).

[ELECTROENCEPHALOGRAM ACTIVITY PRODUCED BY TEMPORARY INACTIVATION OF THE CAUDAL PART OF THE BRAIN STEM] Attivazione elettroencefalografica prodotta per mezzo di inattivazione temporanea delle parti caudali del tronco dell'encefalo, by F. Magni, G. Moruzzi and others. [1959] 7p. incl. refs. (AFOSR TN-59-972) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)-1125 and Rockefeller Foundation) Unclassified

Presented at meeting of the Ital. Soc. of EEG and Neurofisiologia, Rome (Italy), Nov. 22, 1958.

Also published in Riv. Neurol., v. 29: 129-132, Apr. 1959.

The experiments described in this report are intended to obtain a temporary and reversible functional inactivation of limited portions of the encephalic trunk. Thiopental sodium barbiturate is used because of its promptness and short duration of its action. The possibility is suggested of selectively treating the caudal portions of the encephalic trunk and administering barbiturate by endoarterial rather than by intravenous means so as to cause the same activity at smaller doses.

1624

Pisa U. Inst. of Physiology (Italy).

EVIDENCE FOR THE EXISTENCE OF AN ELECTROENCEPHALOGRAPHIC SYNCHRONIZATION MECHANISM ORIGINATING IN THE LOWER BRAIN STEM, by J. P. Cordeau and M. Mancía. [1959] [14]p. incl. diagrs.

refs. (AFOSR-TN-59-973) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(514)-1125 and Rockefeller Foundation) AD 226322 Unclassified

Published in Electroencephalog. and Clin. Neurophysiol., v. 11: 551-564, Aug. 1959.

Cats with brain stem hemisections situated between the midmedullary and midpontine levels show asymmetry in the electrocortical activity of the 2 cerebral hemispheres, the contralateral side showing the greater tendency to synchronization while the ipsilateral hemisphere remains constantly desynchronized. Control experiments show that asymmetry is unlikely to be due to an irritation of the ascending reticular system by the lesion. EEG asymmetry persisted after denervation of both carotid sinuses and bilateral vagotomy. These results are considered valid evidence in favor of an EEG synchronizing mechanism in the caudal portion of the brain stem. (Contractor's abstract)

1625

Pisa U. Inst. of Physiology (Italy).

RESEARCH ON THE RELATION OF THE BRAIN STEM RETICULAR FORMATION TO ANIMAL BEHAVIOR, by G. Moruzzi. Dec. 15, 1956-Dec. 15, 1958, 16p. incl. refs. (Technical rept. no. 1) (AFOSR-TR-59-39) (AF 61(514)1.25) AD 214193; PB 142276 Unclassified

Following a chronic transection of the brain stem at the border between the mesencephalon and pons, the EEG and ocular behavior is that of a cat deeply asleep, although an EEG arousal may be obtained with olfactory stimulations. When the trigeminal inflow is still disconnected from the cerebrum, but the brain stem transection is carried out a few millimeters caudally, the animal shows EEG and ocular behavior of alertness. Following unilateral transection of the midbrain EEG sleep patterns are recorded from the ipsilateral cerebral hemisphere. This effect is observed also (a) in the midpontine pretrigeminal cat, (b) when the lesion is limited to the midbrain tegmentum, sparing the *lemnisci* and the *pes pedunculi* while (c) following compensation a latent EEG asymmetry can be unveiled with small doses of barbiturate. The hypothesis is made that the ascending reticular system separates into 2 distinct paths, 1 for each hemisphere, at the rostral mesencephalic level. Following unilateral midpontine transection there is a greater tendency to EEG synchronization in the opposite cerebral hemisphere. Following midpontine ligation of the basilar artery, intravertebral injection of Thiopental in the unanesthetized "encéphale isolé" cat evokes EEG arousal, while EEG sleep patterns are produced by intracarotid injection of the same or smaller doses. The following hypothesis is made in an attempt to interpret the functional significance of the synchronizing structures of the brain stem. While the reticular activating system is excited by any sudden change in the environment

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the synchronizing structures mainly localized in the lower brain stem would be bestowed with the opposite property of responding with an avalanching increase of their activity whenever a monotonous sensory stimulation is applied. This would explain the so-called Pavlovian sleep, i.e., the soporific influence of repetitive, unconditioned or conditioned, sensory stimulations. EEG and behavioral studies on the intact and on the thalamic pigeon have been started. Preliminary investigations on both cerebral hemispheres and optic lobes have failed to find an EEG test with the striking clarity of the EEG arousal in mammals. Following ablation of one cerebral hemisphere the evoked response of the underlying optic lobe to the photic stimulation of the contralateral eye is increased by (a) blindfolding, (b) cocaine and (c) enucleating the other eye. It is also respectively increased and decreased by local cocaine and strychnine of the contralateral optic lobe.

1626

Pisa U. Inst. of Physiology (Italy).

[VARIATIONS IN THE TIME OF THE HABITUATION PHENOMENA OF THE POTENTIAL CAUSED BY THE LIGHT STIMULATION IN THE OCCIPITAL CORTEX AND IN THE LATERAL GENICULATE] Diverso andamento nel tempo dei fenomeni d'abitudine del potenziale evocato dalla stimolazione fottica nella corteccia occipitale e nel corpo genicolato laterale, by A. Cavagioni, G. Giannelli, and G. Santibañez-H. [1959] [2]p. (AFOSR-TN-59-464) [AF 61(052)107] AD 215269
Unclassified

Also published in Boll. Soc. Ital. Biol. Sper., v. 35: 301-302, 1959.

The experiments were carried out on the cat with permanently implanted electrodes. The spontaneous electrical activity of the cerebral cortex and the primary response at the level of visual cortex by means of wires fixed to the cranium. The activity of the lateral geniculate body was registered with a bipolar electrode. Six days after the treatment, the animals were placed in an acoustically insulated cage and stimulated with short luminous stimuli of constant intensity and duration, with a frequency of 1/sec. The potentials caused by the cortex and the electrical activity of the geniculate body were registered on an oscillograph, at the same time, the electroencephalogram was registered on a common writing apparatus.

1627

Pisa U. Inst. of Physiology (Italy).

ON THE MECHANISM OF THE EEG SLEEP PATTERNS ELICITED BY ACUTE VISUAL DEAFFERENTATION, by A. Arduini and T. Hirao. [1959] 27p.

incl. diagrs. refs. (AFOSR-TN-59-466) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)107 and Rockefeller Foundation) AD 215271
Unclassified

Also published in Arch. Ital. Biol., v. 97: 140-155, 1959.

In the midpontine pretrigeminal cat the effects of a functional visual deafferentation produced by ischemic anoxia have been studied on the EEG recorded from different areas of the cerebral cortex. Acute reversible visual deafferentation was followed by EEG sleep patterns in the occipital, parietal and temporal areas, hence on the entire neocortex with the only exception of the frontal fields. These effects of the functional visual deafferentation were not duplicated by darkness nor by dark adaptation. After abolition of the cerebellar outflow (destruction of nucleus dentatus and nucleus interpositus, or severance of the superior cerebellar peduncles) the electrical rhythms of the frontal areas were also synchronized during the ischemic anoxia of the retina. The conclusion is drawn that the tonic retinal discharge which is present in the dark, is responsible for the maintenance of the EEG activation patterns in the acute midpontine preparations. (Contractor's abstract)

1628

Pisa U. Inst. of Physiology (Italy).

EFFECTS OF REPETITIVE PHOTIC STIMULATION ON RESPONSES EVOKED IN THE LATERAL GENICULATE BODY AND THE VISUAL CORTEX, by A. Cavagioni, G. Giannelli, and G. Santibañez-H. [1959] [10]p. incl. diagrs. refs. (AFOSR-TN-59-512) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)107 and Rockefeller Foundation) AD 234575
Unclassified

Also published in Arch. Ital. Biol., v. 97: 266-275, 1959.

Experiments were carried out on unrestrained, unanesthetized cats with implanted electrodes in the visual cortex and in the lateral geniculate body. Flashes of light were presented to the cats at a frequency of 1 per sec. When the animals were introduced into the cage they showed some signs of agitation, but later on they became behaviorally quiet. At this time the EEG was still activated and the evoked potentials were present. After about 2 hr of stimulation the EEG became synchronized while the evoked potentials started to wane and then to wax again. They finally disappeared, 1st on the cortex and later in the lateral geniculate body. When an extra stimulus was applied to other sensory receptors, the EEG arousal paralleled the re-appearance of the evoked potentials (disinhibition). The results of these experiments are discussed with particular regard to the hypothesis of the reticular mechanism of habituation. (Contractor's abstract)

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1629

Pisa U. Inst. of Physiology (Italy).

CHANGES OF PHOTICALLY EVOKED POTENTIALS IN THE VISUAL PATHWAY OF THE CERVEAU ISOLÉ CAT, by M. Mancía, M. Meulders, and G. Santibañez-H. [1959] [21]p. incl. diagrs. refs. (AFOSR-TN-59-783) (AF 61(052)107) AD 234576 Unclassified

Also published in Arch. Ital. Biol., v. 97: 378-398, 1959.

A study of the effect of repetitive photic stimulation on the evoked responses of the lateral geniculate body and primary visual cortex has been performed in cerveau isolé cats. The following results have been obtained: (1) the phenomenon designated as habituation occurs at both cortical and subcortical levels under these experimental conditions; (2) olfactory stimulation produces dishabituation of visual potentials and EEG arousal; (3) midbrain reticular activation, yielding EEG arousal, produces clear-cut dishabituation; and (4) intravenous injection of small doses Nembutal (1-2 mg/kg) abolishes both reticular arousal and dishabituation, while leaving habituation unaffected. The conclusion is drawn that the brain stem structures lying caudally to the transection are not essential for producing sensory habituation. The close parallelism between dishabituation and EEG arousal suggests actually that the reticular activating system is essential for the process of sensory dishabituation. (Contractor's abstract)

1630

Pisa U. Inst. of Physiology (Italy).

CHANGES OF PHOTICALLY EVOKED POTENTIALS IN THE VISUAL PATHWAY OF THE MIDPONTINE PRETRIGEMINAL CAT, by M. Mancía, M. Meulders, and G. Santibañez-H. [1959] [15]p. incl. diagrs. refs. (AFOSR-TN-59-784) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)107 and Rockefeller Foundation) AD 234577 Unclassified

Published in Arch. Ital. Biol., v. 97: 399-413, 1959.

The present experiments are concerned with the phenomenon of visual habituation in the midpontine pretrigeminal cat. At the beginning of the experiment the potentials evoked by repetitive flashes of white light on visual cortex and lateral geniculate body are easily observed, while the EEG is almost persistently desynchronized. Only after 20-22 hrs of iterative stimulation do the responses decrease in amplitude, first in the visual cortex and later in the lateral geniculate body. At this time the EEG activity becomes synchronized. When an extrastimulation is applied, an EEG arousal and a parallel visual dishabituation are observed. Electrical stimulation of the midbrain reticular formation before habituation slightly depresses the responses of the lateral geniculate body, but clearly reduces the visual cortical potentials.

After habituation the same reticular stimulation disrupts the synchronous rhythms elicited by the repetitive stimulation while the evoked potentials reappear both on visual cortex and lateral geniculate body. This effect (dishabituation) is fully reversible. Small doses of Nembutal (4-6 mg/kg) injected intravenously in the habituated animals, do not abolish "habituation", although the EEG arousal elicited by electrical stimulation of the midbrain reticular formation is abolished. Large doses of Nembutal (15-25 mg/kg) are followed by reappearance of both types of evoked responses in confirmation of results of other authors. The results of these experiments are discussed in relation to the reticular hypothesis. The conclusion is drawn that the reticular activating system is not involved in the mechanism of habituation but that is likely to play an important role in the opposite mechanism of dishabituation. The long time required for producing visual habituation in the midpontine pretrigeminal cat, an observation that contrasts strikingly with those made in the cerveau isolé preparation, may be explained by the great tendency to EEG activation which characterizes the midpontine animals. (Contractor's abstract)

1631

Pisa U. Inst. of Physiology (Italy).

DIRECT PYRAMIDAL INFLUENCES ON THE DORSAL-COLUMN NUCLEI, by F. Magni, R. Melzack and others. [1959] [21]p. incl. diagrs. refs. [Technical note no. 6] (AFOSR-TN-59-785) (AF 61(052)107) AD 234578 Unclassified

Also published in Arch. Ital. Biol., v. 97: 357-377, 1959.

In curarized cats having a postcollicular section sparing the pes pedunculi, the pyramidal track was stimulated at midbrain levels and in the internal capsule, and the responses of the dorsal-column nuclei were recorded. Postsynaptic responses to stimulation of the pyramidal track can be recorded at the dorsal-column nuclei. These responses are elicited by direct relays from the pyramidal system to the sensory nuclei without mediation through the reticular formation. The pyramidal system is capable of diminishing the post-synaptic responses of the dorsal-column nuclei to somatic sensory nerve stimulation. (Contractor's abstract)

1632

Pittsburgh U. [Dept. of Chemistry] Pa.

THE HYDRATES OF THE TETRA n BUTYL AND TETRA i-AMYL QUATERNARY AMMONIUM SALTS, by G. A. Jeffrey. June 1959, 12p. incl. table, refs. (AFOSR-TN-59-475) (AF 49(638)456) AD 215718; PB 146: 27 Unclassified

The hydrates of tetra n-butyl and tetra i-amyl quaternary ammonium salts have been prepared. They form

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a tetragonal isomorphous crystal series. These compounds are believed to be of the clathrate type, similar in general character to the gas hydrates.

1633

Pittsburgh U. Dept. of Physics, Pa.

STRENGTHS AND WIDTHS OF MOLECULAR SPECTRAL LINES IN THE INFRARED, by H. Babrov, G. Ameer, and W. Benesch. Final rept. Dec. 1959, 109p. incl. diagrs. tables, refs. (AFOSR-TR-59-207) (AF 18(600)986) Unclassified

The primary purpose of this work is the measurement of absolute line widths as a function of J for the vibration-rotation lines of the fundamental band of HCl. Both self broadening and foreign gas broadening were studied. A secondary purpose of this work is the determination of the line strengths of this HCl band. A portion of this work has been described elsewhere (item no. 1635, Vol. III). Here the previous work is expanded to include a greater variety of broadening gases and some small corrections are made to the previously published data.

1634

Pittsburgh U. Dept. of Physics, Pa.

MOLECULAR COLLISION CROSS SECTIONS FROM INFRARED ABSORPTION MEASUREMENTS, by H. Babrov, G. Ameer, and W. Benesch. [1959] [6]p. incl. diagrs. tables, refs. [AF 18(600)986] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 67, Jan. 28, 1959. (Title varies)

Published in Jour. Chem. Phys., v. 33: 145-150, July 1960.

Through measurement of the equivalent width (fractional integrated absorption) of collision-broadened lines of the P branch of the HCl fundamental vibration-rotation at 3.5μ , the Lorentz half-widths of these lines have been determined and optical collision cross sections deduced therefrom. The cross sections which have been obtained are those for collisions between HCl molecules and Ar, CO₂, CO, D₂, H₂, HBr, He, Ne, N₂, O₂, as well as other molecules of HCl. One of the more interesting aspects of these cross sections is their dependence on the rotational state of the absorbing molecule and the various forms which this J dependence takes for the different foreign gases. The line widths range between the extremes of 0.233 and $0.0111 \text{ cm}^{-1} \text{ atm}^{-1}$ while the collision cross sections range between 3.04×10^{-14} and $0.091 \times 10^{-14} \text{ cm}^2$. Also reported are recently meas-

ured values of the strengths for the first 8 lines of the P branch of the HCl fundamental. The strength of this band based on these measurements has been found to be $143 \pm 5 \text{ cm}^{-2} \text{ atm}^{-1}$ at 300°K. (Contractor's abstract)

1635

Pittsburgh U. Dept. of Physics, Pa.

LINE STRENGTHS AND WIDTHS IN THE HCl FUNDAMENTAL BAND, by H. Babrov, G. Ameer, and W. Benesch. [1959] [16]p. incl. diagrs. tables, refs. (AF 18(600)986) Unclassified

Published in Jour. Molec. Spectros., v. 3: 185-200, Apr. 1959.

Through the application of a method which varies simultaneously the optical density and the foreign gas broadening, the strengths and widths of the first 8 lines of the P-branch of the HCl fundamental vibration-rotation band were obtained with a single absorption cell. The value of the band strength obtained therefrom is $150 \pm 5 \text{ cm}^{-2} \text{ atmos}^{-1}$ at 300°K. After a smoothing of the individual line strengths in accordance with the theoretical distribution, measurements were made of the line widths for both self broadening and nitrogen broadening. Optical collision diameters were computed for both self and foreign gas broadening. (Contractor's abstract)

1636

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THEORY OF SUPEREXCHANGE, by F. Keffer and T. Oguchi. [1959] [7]p. incl. table, refs. (AFOSR-TN-59-192) (AF 49(638)323) AD 211439 Unclassified

Also published in Phys. Rev., v. 115: 1428-1434, Sept. 15, 1959.

The Dirac-Van Vleck-Serber spin-operator expansion, first applied by Anderson to the Kramers superexchange problem, is extended, simplified, and systematized in order to handle all overlap contributions arising from a number of interacting configurations. The linear cation-anion-cation (e.g.,

$\text{Mn}^{++}-\text{O}^{--}-\text{Mn}^{++}$) 4-electron problem is worked out in detail, taking account of all contributions from configurations (A) ionic, (B) electron transferred to right, and (C) electron transferred to left. Group symmetry requirements are invoked; and these, together with a simple approximation equivalent to perturbation theory, are shown to reduce the complicated matrix formulation to a single linear equation. The solution contains terms previously obtained, and a number of important extra terms. All superexchange terms are 4th order or higher in the overlap S. A rough numerical evaluation with

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modified Slater wave functions appropriate to MnO-type crystals yields an effective superexchange integral of the required size. Brief consideration is given to configurations in which 2 electrons are transferred, in particular (D) simultaneous transfer of electrons to right and to left (Slater mechanism). (Contractor's abstract)

1637

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THEORY OF THE OVERHAUSER EFFECT IN FERRO- AND ANTIFERROMAGNETS, by T. Oguchi and F. Keffer. [1959] 38p. incl. diagrs. refs. (AFOSR-TN-59-193) (AF 49(638)323) AD 262825 Unclassified

Also published in Jour. Phys. and Chem. Solids, v. 25: 405-421, Apr. 1964.

The theory of the Overhauser effect as formulated from general statistical-mechanical arguments indicates that a forced statistical redistribution may be made to occur in any subsystem A whose principal contact with a heat bath C is indirectly routed through some other statistically distributed system B. For nuclei (system A) in ferro- and antiferromagnets the $k = 0$ magnons (and magnons degenerate in energy with these) form the system B, while the remainder of the magnon spectrum is in effect combined with the lattice into system C. Probably the nuclei are sufficiently isolated from direct contact with C; if not, they may forceably be so isolated by intense resonance excitation of a large number of $k = 0$ magnons at a low temperature. Under conditions of power saturation but below the onset of nonlinear instabilities (perhaps also above, but not considered) an Overhauser-type enhancement of nuclear polarization is shown to occur. This may take place via two- and three-magnon processes. In antiferromagnets the former processes are shown to lead to an antiferromagnetically polarized nuclear array, the latter to ferromagnetic nuclear arrays which, depending upon which antiferromagnetic resonance mode is excited, will be polarized either up or down. (Contractor's abstract)

1638

Pittsburgh U. [Sarah Mellon Scaife] Radiation Lab., Pa.

LIGAND FIELD THEORY AND THE ABSORPTION SPECTRA OF $MnCl_2$ AND $MnBr_2$, by R. Pappalardo. [1959] [12]p. incl. diagrs. tables, refs. (AFOSR-TN-59-458) (AF 49(638)323) Unclassified

Also published in Jour. Chem. Phys., v. 31: 1050-1061, Oct. 1959.

Optical absorption spectra of $MnCl_2$ and $MnBr_2$ at room temperature and 78°K are reported and discussed. Parameters of electrostatic interaction and internal field are derived. Koide and Pryce's formalism to compute

transition probabilities is extended to 4T levels. Many properties of the absorption spectra are well explained by the ligand field theory. (Contractor's abstract)

1639

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

STUDY OF THE WURTZITE-TYPE BINARY COMPOUNDS. IV. THEORY OF DOUBLE REFRACTION, by F. Keffer. [1959] [5]p. incl. tables, refs. (AFOSR-TN-59-707) (AF 49(638)323) Unclassified

Published in Jour. Chem. Phys., v. 32: 62-66, Jan. 1960.

The Ewald-Born theory of double refraction is applied to wurtzite-type compounds. Except for the small distortion and polarization, these compounds have identical near-neighbor symmetry to zinc blende (cubic) structures, and hence the double refraction is caused primarily by the distant-neighbor interactions. The effects of anisotropy of the Lorentz-Lorentz force and of the Coulomb force are calculated. In the (ionic) approximation of zero cation polarizability the theory predicts a double refraction larger than the measured one by a factor ~ 2 for all six compounds that have been measured. In the (covalent) approximation of zero effective ionic charge the theory underestimates the double refraction of AlN, but may be made to agree with the measured values of the other compounds by a suitable choice of atomic polarizabilities. In both approximations the theory predicts $n_o < n_e$, in agreement with long-wavelength observations. Anisotropic interaction of polarized light with the solid as a whole, as in exciton transitions, seems to account for the inversion to $n_o > n_e$ near the absorption edge of CdS. (Contractor's abstract)

1640

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

NUCLEAR QUADRUPOLE RESONANCES USING IMPURITY MOLECULES AS PROBES, by R. Baer and C. Dean. [1959] [2]p. incl. tables, refs. (AFOSR-TN-59-750) [AF 49(638)323] Unclassified

Also published in Jour. Chem. Phys., v. 31: 1690-1691, Dec. 1959.

Frequency shifts for p-dichlorobenzene in several compounds are listed as a survey to test the feasibility of using impurities as probes within materials in which a quadrupole resonance does not otherwise occur. The resonance widths and shifts indicated that enough were homogeneous solid solutions to verify the utility of the technique. Interpretation of the data presented is given and suggestions made for future experiments at intermediate temperatures.

AIR FORCE SCIENTIFIC RESEARCH

1641

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

THEORY OF SPIN-WAVE INTERACTIONS IN FERRO- AND ANTIFERROMAGNETISM, by T. Oguchi. [1959] [7]p. incl. table, refs. (AFOSR-TN-59-751) [AF 49-(638)323] Unclassified

Published in Phys. Rev., v. 117: 117-123, Jan. 1, 1960.

The spin-wave theory in an ideal Heisenberg model of a ferromagnet is studied using Holstein and Primakoff's method including the spin-wave interactions. Several earlier published results of the correction to the spontaneous magnetization produced by spin-wave interactions were in disagreement with each other, and they were not in agreement with Dyson's result which is regarded as rigorous at low temperatures. The author's results are in agreement with Dyson's to the order in which they have been considered. The method can be applied to antiferromagnetism easily. The correction arising from interactions between spin waves have been obtained. The correction term is quite small. This means that the simple theory neglecting the spin-wave interactions is sufficient for practical purposes.

1642

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

SIDE-BAND SUPPRESSION FOR SELF-QUENCHED SUPERREGENERATIVE SPECTROMETERS, by V. Rehn and C. Dean. [1959] [2]p. incl. diags. (AFOSR-TN-59-1130) (AF 49(638)323) Unclassified

Also published in Rev. Scient. Instr., v. 31: 72-73, Jan. 1960.

An earlier article (PIT.05:001, Vol. II) described a system which uses a modulated quench frequency to suppress the multiple-side-band responses of an externally quenched superregenerative rf spectrometer. Subsequent investigation has shown that, although the effective audio gain over the range of a self-quenched spectrometer changes tremendously over the range of allowable quench frequencies, its basic signal-to-noise ratio remains fairly constant. Thus effective compensation can be achieved by feeding the signal from it through a variable-gain audio amplifier. A suitable amplifier was designed to follow this spectrometer with 1 stage of audio amplification with a gain of roughly 15. It is reported that the effective audio gain of the superregenerative spectrometer becomes quite small at the higher quench frequencies. The spectra for 1 of the Zeeman split lines in a single crystal of para-dichlorobenzene is shown. Its quench frequency was 24 kc whereas it was modulated from 32 to 15 kc using a triangular wave from a Hewlett-Packard 202A low frequency function generator.

1643

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

SIMPLE AMPLITUDE-STABILIZER TWIN-T AUDIO OSCILLATOR, by C. Dean. [1959] [2]p. incl. diags. (AFOSR-TN-59-1131) (AF 49(638)323) Unclassified

Also published in Rev. Scient. Instr., v. 31: 213-214, Feb. 1960.

Application is made of an amplitude stabilization of oscillators by means of nonlinear resistors. The result is an oscillator which can be made by clipping a signal from the output of a narrow-band tuned amplifier against fixed reference voltages to form approximately a square wave, and by using this wave form as the feedback signal at the input of the tuned circuit. The construction is such that an excellent amplitude stability is achieved without having to rely either on the inception of nonlinearity in the frequency determining circuit or on feedback gain controls to limit the oscillation level. This type oscillator can be constructed around twin-T feedback tuned circuits. Coupled to a commercial tuned amplifier, it is shown that the external circuit need only isolate the diodes from the amplifier output sufficiently to avoid loading the amplifier unduly, and to provide the clipping at a low enough level to permit essentially linear operation of the amplifier since the output of these units at their center frequency is in phase with the input and amplified to a higher level.

1644

Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

RESEARCH STUDIES ON ANTIFERROMAGNETIC RESONANCE, PARAMAGNETIC RESONANCE IN PHOSPHORS, FOREIGN ATOMS IN SILVER HALIDES AND NUCLEAR RESONANCE. Mar. 1959 [25]p. incl. diags. tables, refs. (AF 49(638)323) AD 228953 Unclassified

This report is a compilation of publication reprints on research done on Contracts AF 18(500)892 and AF 49-(638)323. For abstracts see items PIT.02:012, 023; 05:001, 002, 005, Vol. II.

1645

Pittsburgh U. [Sarah Mellon Scaife] Radiation Lab., Pa.

TEMPERATURE MEASUREMENT BY NUCLEAR QUADRUPOLE RESONANCE, by C. Dean. [1959] 6p. [AF 49(638)323] Unclassified

Presented at Nat'l. Conf. on Stratospheric Meteorology, Minneapolis, Minn., Aug. 30-Sept. 3, 1959.

A nuclear quadrupole resonance (NQR) spectroscopic system is described which is noted as the simplest one that would be able to obtain and transmit the temperature

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information with reliability and essentially automatically. This system consists of a conventional 1-tube self-quenched superregenerative spectrometer stage and 2 multivibrators for developing triangular modulating waveforms. The superregenerative circuit provides a tremendous amplification of the effect over the actual amount of power absorbed by the sample. The resonance frequency (rf) is measured by matching the occurrence of a resonance signal. The proper matching is assured when the apparent rf is not affected by the periodic alteration of the spectrometer pulse rate. In the laboratory the rf is usually detected in the plate circuit of the superregenerative tube, and the resulting audio frequency signal is amplified and viewed on an oscilloscope. The rf radiated by the spectrometer can be picked up by a radio receiver a short distance away, and all measurements made with that signal. For more distant direct transmission, an rf power amplifier could transmit 1 of the harmonics, or the rf could be used to modulate a microwave carrier.

1646

Plasmadyne Corp., Santa Ana, Calif.

HEATING AND CONFINEMENT OF A PLASMA BY A MAGNETIC FIELD OF EXTERNAL ORIGIN AND WITH A SHORT RISE TIME, by H. G. Loos. [1959] [2]p. incl. diagr. [AF 49(638)655] Unclassified

Published in Phys. Rev. Ltrs., v. 2: 282-283, Apr. 1, 1959.

Results of experiments in which a fully ionized plasma is heated and confined by a magnetic field that is suddenly induced by a current in an external conductor are reported. A good separation between the magnetic field and the confined plasma is retained for a time interval small compared with the decay time $R^2/\mu\sigma$. It is shown that during such a small interval, the plasma may be manipulated using the "magnetic piston" effect at the plasma boundary, if the linear ion density N_l is large enough. The basic cylindrical configuration used in this experiment is described including the properties lost when magnetic mirrors are introduced at its ends to reduce excessive particle loss.

1647

Plasmadyne Corp., Santa Ana, Calif.

[INITIAL BREAKDOWN PROCESS OF GASEOUS CONDUCTORS] (Abstract), by H. G. Loos. [1959] [1]p (Bound with 1's AFOSR-TN-59-770; AD 241053) [AF 49(638)655] Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif.

A study is planned of the initial breakdown of a gas in

an electrodeless discharge in which the macroscopic parameters are uniform along the electric field lines, while these parameters may change in the direction normal to the electric field. An attempt will be made to formulate an analytical model of the governing processes occurring in the region where currents first build up, assuming that the gas is initially only slightly ionized. Since charged particles approaching the breakdown region may be turned back because of the gradient in magnetic pressure which is set up by the current, the breakdown region may be occupied by different particles at different times. Ionization is expected to occur both inside and outside the current region, since charged particles that encounter the current region may be reflected with increased energy and cause ionization at some distance from the current region. An analytical study will be made of the dynamics and the internal state of the breakdown region for the case of a cylindrical plasma and a longitudinal field. An experiment will be undertaken to observe the motion of the luminous region in a gas during the initial stages of breakdown under a high-transient magnetic field. A cylindrical configuration will be chosen that is long enough so that in a central portion the parameters remain uniform along the axial direction for time intervals long enough to permit observation of the initial breakdown processes.

1648

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

ARGON MOLLIER CHART, by G. L. Cann and A. C. Ducati. Feb. 27, 1959, 10p. incl. diagr. tables. (Technical note no. P-3TN029-54) (AFOSR-TN-59-247) [AF 49(638)54] AD 212227; PB 140223 Unclassified

Argon was used extensively in shock-tube and arc plasma studies where the temperature is high enough to cause an appreciable % of ionization. Any analysis of the results then requires some extensive calculations to determine the state of the gas. In most cases the calculations neglect the effect of electronic excitation by using the Saha equation. In order to eliminate the errors introduced by this assumption and to have available the max amount of information about the gas properties, a Mollier Chart was constructed. The chart covers the temperature range from 1000 to 14,000°K and the pressure range from 10 to 10^{-4} atm. (Contractor's abstract)

1649

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

EQUILIBRIUM THERMODYNAMIC PROPERTIES OF HELIUM TO 60,000°K, by G. L. Cann and A. C. Ducati.

AIR FORCE SCIENTIFIC RESEARCH

June 18, 1959, 1v. incl. diagrs. tables. (Technical note no. P-4TN069-54) (AFOSR-TN-59-633) (AF 49(638)-54) AD 228710; PB 144864 Unclassified

Helium was considered as a possible propellant for a plasma propulsion system because of its low molecular weight. To obtain reasonable exhaust velocities (greater than 10,000 m/sec) it is necessary to heat the gas to temperatures at which an appreciable % ionization occurs. In order to assess the potentially available exhaust velocities when ionization is present, it is necessary to have a Mollier chart to determine isentropic expansions, hence the thermodynamic properties of helium were computed over a temperature range of 6000-60,000°K and a pressure range of 10^{-4} - 10^{-2} atm. A Mollier chart was constructed from this data. (Contractor's abstract)

1650

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

RESEARCH ON HIGH INTENSITY IONIC JETS, by G. L. Cann and A. C. Ducati. Final technical rept. Nov. 5, 1959, 36p. incl. illus. diagrs. (Rept. no. P-FR109-54) (AFOSR-TR-59-167) (AF 49(638)54) AD 229902; PB 144907 Unclassified

The various steps that have been completed in the development of a practical plasma jet propulsion unit are outlined, and detailed references to the work made. The steps that still need to be completed before a prototype unit can be constructed, are indicated. (Contractor's abstract)

1651

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

RESEARCH ON HIGH INTENSITY IONIC JETS (Abstract), by G. L. Cann and A. C. Ducati. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)54) Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This program has encompassed the following studies: (1) A generalized rocket analysis was made to determine desirable specific impulse, ratio of propellant-to-powerplant mass, ratio of total rocket-to-payload mass, effect of propellant tank structure constant, and other relevant parameters as a function of the mission requirements; (2) Several substances that looked promising from preliminary considerations have been picked, and their thermodynamic properties have been computed and plotted on Mollier charts. To date, argon, helium,

lithium and lithium hydride have been completed. Hydrogen, water and ammonia are being worked on at present; and (3) A rather elaborate facility has been designed around a cantilever suspension of the plasma jet head, constructed, and put into operation for actually measuring the specific impulse, electric energy to jet energy, conversion efficiency, and other relevant parameters for plasma jets exhausting into an ambient pressure as low as 1 mm Hg. Specific impulses of 1100-1200 sec at efficiencies of 50-80 % for helium have been measured to date in this equipment. In order to obtain a more detailed knowledge of the jet, a total pressure probe has been designed and used to measure the radial distribution of total pressure. Thrusts have been computed from these measurements and correlated with the actual thrust measurements.

1652

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME VI. FUSION POWER, by E. J. Hellund. Apr. 24, 1959, 74p. incl. diagrs. tables. (Rept. no. E-6FR049-332) (AFOSR-TN-59-427) (AF 49(638)332) AD 214777; PB 144000 Unclassified

A report is made on the fusion fuels and some of the problems faced in starting a "fusion fire" which include validation of the existence of an actual thermonuclear fusion reaction and the confinement problems. New devices and techniques used in the field among which are the B65 Stellerator, the Oak Ridge DCX, and the Astron plus others are discussed. In addition an analysis is made on the maximum energy that can be expected from certain fuels and the problem of extracting the energy from the fuel.

1653

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME IV. NUCLEAR FISSION REACTORS, by E. J. Hellund. Apr. 24, 1959, 131p. incl. diagrs. tables. (Rept. no. E-4FR049-332) (AFOSR-TN-59-428) (AF 49(638)332) AD 214778; PB 143999 Unclassified

A discussion is given on the problems faced in the design of a nuclear-powered, electrically-driven space ships. The limitations of the engineering materials which require a temperature degradation in order to accommodate them is also discussed. Performance of certain different reactors is presented.

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Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME III. DIRECT ELECTRICAL CONVERTERS, by E. J. Hellund. Apr. 24, 1959, 76p. incl. diagrs. tables. (Rept. no. E-3FR049-332) (AFOSR-TN-59-429) (AF 49(638)332) AD 214779; PB 143998 Unclassified

The criteria are discussed for building a photovoltage cell with pure material such as the silicon solar converter. In addition, an analysis of thermoelectric devices or thermopiles is given. Other direct electrical converters are also mentioned.

1655

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME II. BATTERIES, by E. J. Hellund. Apr. 24, 1959, 102p. incl. diagrs. tables. (Rept. no. E-2FR049-332) (AFOSR-TN-59-430) (AF 49(638)332) AD 214780; PB 161262 Unclassified

A summary is presented of performance characteristics, e.g., structure, power weight ratios, and power volume ratios, whenever available of chemical batteries. Performance data include such items as whr/lb, whr/cu in., behavior at low temperatures, unactivated and activated shelf lives, rechargeability, reliability, open circuit voltage, average operating voltage, and adaptability for particular service. Fuel cells and nuclear batteries are discussed.

1656

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOL. V. NUCLEAR AND SOLAR ENERGY SOURCES (Unclassified title), by D. Ragusa. Apr. 24, 1959, 33p. incl. illus. diagrs. tables. (AFOSR-TN 59-485) (AF 49(638)332) AD 307002

Secret

1657

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME I. MORPHOLOGY, by E. J. Hellund. Apr. 24, 1959 [30]p. incl. diagrs. (Rept. no. E-1FR049-332) (AFOSR-TN-59-103) (AF 49(638)332) AD 227933; PB 144009 Unclassified

A survey and classification was made of various types of power sources which might possibly be used in conjunction with propulsion systems for space vehicles. Codification of these types was systematically developed with the objective in mind of providing a convenient classification by means of which a rapid evaluation on any new proposals can be made. A number of possible new power systems and propulsion systems were brought out. The primary goal in evaluation of all systems is to obtain an unambiguous upper limit to performance, equivalent to that derived for heat engines on the basis of Carnot cycle. (Contractor's abstract)

1658

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOLUME VII. BIBLIOGRAPHIES, by H. Fife. Apr. 24, 1959, 42p. incl. diagrs. refs. (Rept. no. E-7FR049-332) (AFOSR-TN-59-104) (AF 49(638)332) AD 227934; PB 161117

Unclassified

An extensive bibliography is presented in order to take a fresh new look at the electric power sources that have been proposed from time to time which must operate in space. Briefly, this listing arranges possible sources according to whether they are (a) internal (wholly contained within the space vehicle) or external (utilize energy available outside the vehicle), (b) waste (utilize waste products from other functions) or direct storage, and (c) certain detailed categories.

1659

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

A CONTINUOUS HIGH TEMPERATURE GAS FLOW FACILITY FOR MAGNETOHYDRODYNAMIC STUDIES, by V. H. Blackman, J. Chambers, and C. Cobb. June 26, 1959, 39p. incl. illus. diagrs. (Rept. no. T-1TN069-334) (AFOSR-TN-59-681) (AF 49(638)334) AD 225412; PB 143163

Unclassified

In order to study phenomena which require both a long testing time and high temperature, it would be most desirable to combine the steady state flow characteristics of a wind tunnel with the high gas temperature capabilities of a shock tube. This plasma flow facility described was an attempt to accomplish such a union. The facility was set up in order to study the steady state Hall effect in an ionized gas flow and as a convenient arrangement to look at fluctuations introduced into a flow by means of an electric arc heater. It also proved to be useful for preliminary experimental studies of the steady acceleration of an ionized gas flow by means of crossed electric and magnetic fields. (Contractor's abstract)

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1660

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

AN EXPERIMENTAL STUDY OF SPARK STABILIZATION BY A GAS VORTEX, by C. Cobb and V. H. Blackman. Aug. 28, 1959, 32p. incl. illus. diags. (Rept. no. T-5TN099-334) (AFOSR-TN-59-925) (AF 49(638)334) AD 228775; PB 144768

Unclassified

An investigation was conducted to detect transient electrical discharges along the axis of a vortex flow. A time resolved photographic study of spark stabilization and growth in a vortex channel might give information on the stabilization of arcs by vortex motion. Three separate experimental studies were conducted: (1) The photographic demonstration of spark stabilization by a gas vortex; (2) The investigation of radial pressure distribution in the vortex; and (3) The gathering of data on the expansion of a spark channel with time.

1661

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

FLEXURE OF A TWO-DIMENSIONAL ARC UNDER FORCED CONVECTION, by P. G. Thieme. Aug. 25, 1959, 71p. incl. diags. (Rept. no. T-2TN089-334) (AFOSR-TN-59-947) (AF 49(638)334) AD 228540; PB 144488

Unclassified

A rudimentary inquiry is conducted into the nature of the physical mechanisms which maintain an arc in the presence of forced convection. The basic fluid-mechanical and electromagnetic equations are developed for the case of a dilute, 3-component quasineutral arc plasma. The basic equations, in particular the equation of energy balance, are then applied to a simple model of a 2-dimensional arc in a low-Mach-number subsonic flow. The proposed model is based on the notion of a definite, localized zone of ohmic heating. An analogy is qualitatively drawn between the convection-loaded arc model and a structural beam with a disturbed load. The equation of energy balance provides the temperature distribution through the arc model from which the curvature, flexural rigidity and deflection curve are determined. Also included is a tentative criterion for blowout. (Contractor's abstract)

1662

[Plasmadyne Corp.] Giannini Research Lab., Santa Ana, Calif.

SPARK STABILIZATION BY A GAS VORTEX (Abstract), by C. Cobb, J. Chambers, and V. [H.] Blackman. [1958] [1]p. [AF 49(638)334]

Unclassified

Presented at meeting of the Amer. Phys. Soc., San Diego Calif., Nov. 24-26, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 197, Mar. 30, 1959.

A rotating mirror camera and a Kerr cell camera have been used to study photographically the buildup of a spark channel in a gas vortex. The spark is initiated by discharging either a low inductance capacitor or a length of coaxial cable between electrodes at either end of a cylindrical chamber which is 1/2 in. in diam. and from 1 in. to 1 1/8 in. in length. The coaxial cable can give a square current pulse with a duration of up to 3 μ sec. The vortex is formed by injecting gas tangentially into the cylindrical chamber through an orifice in the wall and allowing the gas to escape through an axial orifice in the electrodes. The pressure distribution has been determined over a wide range of inlet and outlet conditions by means of movable pressure taps. Radial pressure gradients are as high as 4000 psi/in. with a minimum pressure on the axis of 3 psia when the flow exhausts into atmospheric pressure. Photographs will be presented to illustrate the stabilizing influence of the vortex. This arrangement is also being used to study the propagation of a cylindrical shock into a known pressure gradient.

1663

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

SOME DYNAMICS PROBLEMS OF THE PUNCH METHOD OF HEATING AND ACCELERATION OF PLASMAS, by H. G. Loos. Feb. 1959, 32p. incl. diags. (Technical note no. T-2TN029-335) (AFOSR-TN-59-256) (AF 49(638)335) AD 212256; PB 140055

Unclassified

A few dynamics problems encountered in punch discharges are discussed. The fully ionized plasma is supposed to interact with the magnetic field only at the plasma boundary; the analysis is limited to time intervals in which the effect of ion-ion collisions may be neglected. The type of discharge for the basic cylindrical punch geometry depends solely on 2 non-dimensional parameters. A scaling law is derived for changes for which these 2 parameters remain the same. For compressions or expansions that take place in a time short compared with the ion-ion collision time, but which have a current sheet velocity that is small compared with the mean ion speed, the discharge coil with the moving plasma inside assumes a constant inductance. An introduction is also given for the analysis of discharge dynamics for punch configurations with a general axisymmetric geometry. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

1664

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

RELAXATION HEATING OF A PLASMA BY SURFACE INTERACTION WITH A MAGNETIC FIELD, by R. P. Treat. Oct. 15, 1959, 44p. incl. diagrs. (Rept. no. T-3TN109-335) (AFOSR-TN-59-1151) (AF 49(638)335) AD 230031; PB 144972 Unclassified

The heating of a fully ionized deuterium plasma by collisional relaxation for temperatures of the order of 1 kev is explored. The model used for the study consists of a long cylindrical plasma column confined and manipulated by an axial magnetic field that is induced by currents flowing in a 1-turn coil surrounding the plasma. Conditions are such that the field is excluded from the interior of the plasma: the interaction between plasma and field is essentially a surface phenomenon. The heating due to collisional relaxation is investigated for an idealized cycle. For given ion density and circuit parameters, i.e., the capacitance, inductance and voltage of the capacitor bank connected to the coil, initial plasma temperatures and initial radii are specified for which there is appreciable collisional relaxation while the plasma remains relatively homogeneous. Since initial temperatures are of the order of 10^{-1} kev and the initial radii, ion densities, and circuit parameters are realizable, the results are encouraging. (Contractor's abstract)

1665

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

PROBLEMS OF MAGNETIC PROPULSION OF PLASMA, by R. W. Wanek. [1959] [7]p. incl. illus. diagrs. refs. (AFOSR-TN 59-1335) (AF 49(638)335) AD 241130 Unclassified

Also published in Proc. Tenth Internat'l. Astronaut. Congress, London (Gt. Brit.) (Aug. 30-Sept. 5, 1959). Vienna, Springer-Verlag, v. 1: 131-137, 1960

Also published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass., (Oct. 7-8, 1959), Boston, v. 1: 141-148, 1959. (Title varies) (AFOSR-637)

Some of the basic approaches to intermittent magnetic plasma propulsion are summarized and reviewed in terms of the features deemed important for practical space applications. The class of inductively coupled devices is examined in detail and some of the requirements necessary for efficient magneto-kinetic energy transfer are outlined. Experimental results obtained with symmetric high field collapse thrusters are presented.

1666

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

HEATING AND CONFINEMENT OF A PLASMA BY A MAGNETIC FIELD OF EXTERNAL ORIGIN AND WITH A SHORT RISE TIME, by H. G. Loos. Feb. 1959, 6p. incl. diagr. (Rept. no. PLR-6) [AF 49(638)335] Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 282-283, Apr. 1, 1959.

The use of a basic cylindrical configuration to heat and confine a plasma, fully ionized by a magnetic field that is suddenly induced by a current in an external conduction is explored. During the small time interval that a good separation between the magnetic field and the confined plasma, the liquid may be manipulated using the "magnetic piston" effect at the plasma boundary, provided that the linear ion density is large enough. It is also shown that heating by translational relaxation requires that an additional lower limit condition on N_1 be satisfied.

1667

Plasmadyne Corp. [Giannini Research Lab.] Santa Ana, Calif.

STUDY OF THE ACCELERATION AND CHANNELING OF PLASMA BY MAGNETIC FIELDS (Abstract), by R. W. Wanek and H. G. Loos. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)335) Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This presentation deals with experimental and theoretical results obtained during the course of a study aimed at accelerating and heating ionized gases by means of strong transient magnetic fields. Recently developed strong magnetic field techniques make available for experimentation field intensities up to 1,000,000 oersteds and hence field pressures well in excess of 10^4 atm. Preliminary experimental results on symmetric and asymmetric collapse geometries is discussed with particular emphasis on their characteristics as intermittent magneto-plasma thrusters. The theoretical work has been concentrated on "punch" discharges with a cylindrical geometry. A fully ionized plasma of cylindrical shape is compressed and heated by a high transient magnetic field induced by currents in an external cylindrical conductor. At present, collisional relaxation heating in the punch configuration is being studied. The motion of the plasma boundary is assumed to be slow compared with the mean ion speed. A generalized equation of state is derived.

AIR FORCE SCIENTIFIC RESEARCH

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Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

ON THE EXISTENCE OF INFINITE ACCELERATION POINTS IN TRANSONIC FLOWS AROUND AIRFOILS WITH FINITE CURVATURE, by S. Nocilla. Dec. 1958 [17]p. incl. diagrs. (Technical note no. 11) (AFOSR-TN-59-197) (AF 61(514)1124) AD 211474; PB 147445
Unclassified

The problem is investigated of the formation of shock waves around airfoils with finite curvature in transonic flow. As a suitable criterion for the theoretical interpretation of the appearance of such a shock wave it is assumed the appearing of a point with infinite acceleration on the physical plane. The conditions which must be fulfilled on the hodograph plane in order that such a point exist, and the properties which the corresponding stream function must possess are studied. The theory is then applied to airfoils with constant curvature. (Contractor's abstract)

1669

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

ON THE STEADY AND NON-STEADY TRANSONIC FLOW WITH ATTACHED SHOCK WAVE ($M_\infty < 1$): NEW RESULTS AND CONJECTURES, by C. Ferrari. Feb. 1959, 31p. incl. diagrs. (Technical note no. 12) (AFOSR-TN-59-338) (AF 61(514)1124) AD 213659; PB 142261
Unclassified

The purpose of this work is to seek the singularity which the potential function ϕ of the field must exhibit in the physical plane in the point A_f , and the stream function ψ must have in the hodograph plane in the point A_0 corresponding to A_f , in order that the tangent in A_f be continuous. There is also determined the wave form in close proximity of A_f as well as demonstrated that the curvature of the wave front exhibits a logarithmic infinity in said point. The law obtained for the variation of velocity along the profile, both before and after the shock although not affording a true demonstration of the property being enunciated herein - permits however to infer that, if the maximum local Mach number is slightly in excess of 1, the transonic flow is continuous, at least if the curvature of the profile in A_f is not null or negative (convex profile). The research is carried out both for the stationary and the non-stationary flow.

1670

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

AERODYNAMIC FIELD NEAR THE STAGNATION

POINT OF A BLUNT SYMMETRICAL AIRFOIL IN HYPERSONIC FLOW WITH γ NEAR UNITY, by A. Muggia. Feb. 1959, 15p. incl. diagrs. (Technical note no. 13) (AFOSR-TN-59-339) (AF 61(514)1124) AD 213660; PB 142262
Unclassified

A blunt symmetrical airfoil in a steady axial hypersonic flow is considered, in the limiting case of free-stream Mach number infinite and ratio of specific heats γ near unity. Viscosity dissociation and ionization are neglected. A method is obtained to determine the aerodynamic field in the neighborhood of the stagnation point. Very simple formulae are determined for velocity and pressure distribution along the airfoil, near the stagnation point. (Contractor's abstract)

1671

Politecnico di Torino. Laboratorio di Meccanica Applicata (Italy).

EFFECTS OF AIR DISSOCIATION AND IONIZATION AT HYPERSONIC SPEED, by G. Jarre. July 1959 [35]p. incl. diagrs. tables. (Technical note no. 14) (AFOSR-TR-59-119) (AF 61(514)1124) AD 225765; PB 143910
Unclassified

An analysis was conducted on the problem of dissociation and ionization of air components at the high temperatures produced by hypersonic speed, either behind a strong normal shock wave or at the wall of an adiabatic flat plate. The state of chemical equilibrium is studied with the aid of a thermodynamic chart of atmospheric air and using simplified schemes of real flows. The dynamic problem of relaxation is also investigated but only in the field of oxygen dissociation. Simplified methods for calculating the length of the relaxation processes are developed, discussed and applied to numerical examples.

1672

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

THE BLASIUS EQUATION WITH THREE-POINT BOUNDARY CONDITIONS, by L. G. Napolitano. [1959] [12]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)693 and National Advisory Committee for Aeronautics under NAW 6480)
Unclassified

Published in Quart. Appl. Math., v. 16: 397-408, Jan. 1959.

The Blasius equation subject to 3-point boundary conditions, describing the interaction between 2 parallel streams, is solved by way of a series in terms of ascending powers of the ratio $\lambda = (u_1 - u_2)/u_1$, where the u_1 's are the outer streams' velocities. The first 3 terms of the series are analytically expressed in terms

AIR FORCE SCIENTIFIC RESEARCH

of the repeated integrals of the complementary error function ($i^n \operatorname{erfc} \eta$) and of the repeated integrals of the square of the successive integrals of the complementary error function ($j^m i^n \operatorname{erfc} \eta$). These functions often appear in problems leading to extended heat-conduction type of equations. A recurrence formula for $j^m i^n \operatorname{erfc} \eta$ is established and formulae relating the functions $i^n \operatorname{erfc} (-\eta)$ and $j^m i^n \operatorname{erfc} (\pm \eta)$ to available tabulated values of the functions $i^n \operatorname{erfc} (\eta)$ are derived. The first 3 approximations to the Blasius function and to its first 2 derivatives are also presented in tabulated form with 4 significant figures. Test on the convergence of the series has been made by comparison with some exact solutions obtained by high speed computing machine. The comparison, extended to the physically essential quantities, shows that: (1) The Blasius function itself is slightly less accurate than its 2nd and 1st derivatives. (2) Two terms of the series for λ up to 0.5 and 3 terms for λ up to 0.7 yield extremely accurate results. The errors in the first 2 derivatives of the Blasius functions are always contained within less than 1%. (Contractor's abstract)

1673

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A REVIEW OF THE WORK PERFORMED AT PIBAL UNDER CONTRACT AF 18(600)694. PART I. ANALYSIS AND ADVANTAGEOUS USE OF INTERFERENCE EFFECTS IN SUPERSONIC FLOWS (Unclassified title). PART II. (Classified title) n.a., Oct. 1958, 9p. incl. refs. (AFOSR-TN-59-8) (AF 18(600)694) AD 304431

Confidential

1674

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

EXPERIMENTAL PRESSURE DISTRIBUTIONS ON CONICAL ELLIPTICAL BODIES AT $M_\infty = 3.09$ AND 6.0, by V. Zakkay and M. Visich, Jr. Mar. 1959, 31p. incl. illus. diagrs. refs. (PIBAL rept. no. 467) (AFOSR-TN-59-10) (AF 49(638)217) AD 208591; PB 139907

Unclassified

Pressure distributions over two elliptical cones having a 16.7° equivalent circular cone, and a ratio of the major to the minor axis of a/b equal to 1.39 and 1.78 are presented for different angles of attack. A hypersonic approach similar to Newtonian is suggested for the determination of the pressure distribution. The resulting pressure distribution as determined by this method compares more favorably with the experimental results than the Newtonian theory. (Contractor's abstract)

1675

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

DISCONTINUITY SURFACES IN MAGNETOFLUIDDYNAMICS, by L. G. Napolitano. Dec. 1958, 38p. (PIBAL rept. no. 503) (AFOSR-TN-59-67) (AF 49(638)217) AD 209842; PB 140039

Unclassified

Presented at meeting of the Amer. Astronaut. Soc., Washington, D. C., Dec. 27-31, 1958.

Also published in *Advances in Astronaut. Sci.*, v. 4: 51-73, 1958.

Investigation was concerned with the macroscopic study of magneto-fluid-dynamic discontinuities for negligible relativistic effects. Jump conditions relating the end states on the two sides of discontinuity surfaces of arbitrary geometry are derived for both the steady and unsteady cases. Applications are presented in connection with: (a) the magneto-fluid-dynamic counterpart of Truesdell-Lighthill-Hayes problem of determining the vorticity jump across a shock, and (b) the existence of magneto-fluid-dynamic slip and/or contact surfaces. (Contractor's abstract)

1676

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

ANALYSIS OF THE LAMINAR COMPRESSIBLE BOUNDARY LAYER CHARACTERISTICS OVER AN ISOTHERMAL FLAT PLATE WITH FINS, by A. Pallone. Feb. 1959, 56p. incl. diagrs. tables. (PIBAL rept. no. 468) (AFOSR-TN-59-275) (AF 49(638)217) AD 212709; PB 140459

Unclassified

A theoretical investigation is presented of the compressible laminar boundary layer characteristics of a flow over an isothermal flat plate with fins. The equations are reduced to a 2-dimensional form by replacing the variation of all quantities in the direction normal to the plane of the fins by average values. The resulting equation is integrated for various free stream Mach numbers, fin characteristics and wall to free stream temperature ratios. Results show that the wall shear stress and consequently the rate of heat transfer decreases with increasing fin height, decreasing fin spacing and increasing free stream Mach number. Reductions of wall shear and rates of heat transfer on the order of 1/3 the values given for a plate with no fins are possible. No marked change on the rate of decrease is noted when the wall temperature is varied. The fin shear and rate of heat transfer show a trend opposite to the one stated for the wall. Increases of drag and the rate of heat transfer are obtained on the order of twice the values given for a flat plate with no fins.

AIR FORCE SCIENTIFIC RESEARCH

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Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

TRANSONIC ROTATIONAL FLOW OVER A CONVEX CORNER, by R. Vaglio-Laurin. Aug. 1959, 56p. incl. diagrs. tables, refs. (PIBAL rept. no. 431) (AFOSR-TN-59-355) (AF 49(638)217) AD 264409; PB 144381
Unclassified

Also published in Jour. Fluid Mech., v. 9: 81-103, Sept. 1960.

A singularity is encountered in the flow field about 2-dimensional and axisymmetric bodies characterized by a sharp corner, where the fluid velocity becomes sonic. Such is the case for several practical configurations in transonic and hypersonic flow. An investigation of this sonic singularity, and the application of results thereof to the analysis of flow fields about blunt bodies in the aforementioned category are presented. It is shown that the problem in question, as many other discontinuity problems, belongs to the family of asymptotic or boundary layer phenomena of mathematical physics. The solution of the 1st approximation equations is given by a series in powers of a variable measuring the distance from the corner with coefficients depending on an appropriate similarity variable. The leading coefficient of the series is independent of 3-dimensional and rotational effects, in complete analogy to the well-known solution of the corner problem in supersonic flow. Detailed results are presented for the leading singularity and for the 1st 2 corrections due to rotationality and axial symmetry of the flow. (Contractor's abstract)

1678

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

ON A NEW APPROACH FOR THE SOLUTION OF NON-SIMILAR BOUNDARY LAYER PROBLEMS, by L. G. Napolitano and A. Ferri. Mar. 1960, 32p. incl. table. (PIBAL rept. no. 507) (AFOSR-TN-59-356) (AF 49(638)217) AD 238697; PB 148557
Unclassified

A new method of solution for non-similar dissipative flow fields is proposed which is essentially based on the description of such flow fields by means of "inner" and "outer" profiles joined along a continuous "matching" line lying within the field itself. The inner and outer profiles are single-parameter profiles derived from the solution of a total differential equation upon which not all the pertinent physical conditions are necessarily imposed. The "inner" profiles are in fact the inner part of solutions for which the conditions of boundness at infinity have not been imposed. The "outer" profiles are the outer part of solutions which do not satisfy the true physical similarity requirements at the wall. It is proved that the basic equations for constant property dissipative isobaric flows in the Prandtl approximation can always be reduced to a total differential equation depending on a

single parameter β . It is also proved that when the similarity conditions in the boundary conditions are not imposed simultaneously at the 2 points (0 and ∞), 6 classes of single-parameter profiles can be generated corresponding to the different types of homogeneous boundary conditions at 0 and of boundness at ∞ . Each class contains infinite profiles for the infinite values of β . Some additional general properties of the above-mentioned equation are proved, and these relate the types of singularities of the solution at ∞ (and of the initial boundary conditions at 0) to the values of β . The matching procedure is derived and discussed, and the detailed application of the method is illustrated for a particular case. The attainment of the 6 classes of solutions is deferred to future work. (Contractor's abstract)

1679

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

ON THE INTEGRAL OF MOMENT OF PRESSURE IN SUPERSONIC FLOW, by L. Ting. May 1959 [14]p. incl. diagrs. (PIBAL rept. no. 449) (AFOSR-TN-59-358) (AF 49(638)217) AD 213684; PB 142238
Unclassified

Also published in Jour. Aero/Space Sci., v. 26: 758-759, Nov. 1959.

The integral of the moment of the disturbance pressure along the line of the interaction of a Mach plane with the cylindrical surface, whose generator is parallel to the undisturbed stream, is shown to be related to the integral of the moment of the prescribed normal velocity along the same line. Its applications in problems of planar systems and wing-body combinations at supersonic speed are presented. (Contractor's abstract)

1680

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

AN EXTENSION OF THE LINEARIZED CHARACTERISTICS METHOD FOR CALCULATING THE SUPERSONIC FLOW AROUND ELLIPTIC CONES, by A. Martellucci. June 1959, 51p. incl. illus. diagrs. tables, refs. (PIBAL rept. no. 517) (AFOSR-TN-59-632) (AF 49(638)217) AD 219218
Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 667-674, Sept. 1960.

The method of linearized characteristics as applied by Ferri to the flow about elliptic cones can be used to determine the surface pressure distribution, even when only linear terms are kept in the boundary conditions, provided an area rule requirement is satisfied. In addition, the method can be applied for angles of attack provided the elliptic body geometry is specified in a manner so as not to distort the cross section. Experimental results were obtained for several conical bodies

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and the results are presented. The surface pressure distribution obtained by this modified method is in reasonable agreement with experiment over the range of Mach number and semidiameter ratio range considered. (Contractor's abstract)

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Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

PRESSURE DISTRIBUTIONS FOR A TWO-DIMENSIONAL BLUNT-NOSED BODY AT DIFFERENT ANGLES OF ATTACK, by A. Ferri and V. Zakay. [1959] [2]p. incl. diagrs. (AF 49(638)217) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 395-396, June 1959.

A few of the more interesting results concerned with work on the boundary conditions near a sonic line are presented. It is pointed out that 2-dimensional body having a circular nose which is extended for an angle of 145° can, at appropriate values of the angle of the attack of the body, have tests performed on it where the elliptic region is limited to the circular part of the body and the sonic points are on the circular region. It is also possible to move one point outside of the circular region. In this case the flow at the nose is not symmetrical, and the stagnation point is not on the radial line parallel to the free-stream direction. The flow at the nose has an anti-symmetrical part which is equivalent to the presence of circulation. The measured pressure distribution and the velocity gradient at the stagnation point for both cases are shown.

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Polytechnic Inst. of Brooklyn [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

AN INVESTIGATION OF THE PRESSURE DISTRIBUTION ON CONICAL BODIES IN HYPERSONIC FLOWS by V. Zakay. [1959] [1]p. incl. diagrs. (AF 49(638)217) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 457, July 1959.

In this note, experimental data on 2 elliptical cones at $M_\infty = 6$ are presented and a hypersonic approach obtained from physical considerations is suggested. The method consists of determining at each point the local normal component of the free-stream velocity with respect to the surface of the body. Then, an equivalent circular cone at zero angle of attack is determined that has the same normal component of the free-stream velocity. The pressure distributions of 2 elliptical cones having a 16.7° equivalent circular cone, and ratios of the major to the minor axis of a/b equal to 1.39 and 1.87 are presented in diagrammatic form for the angles of

attack of 0° , 10° , and 20° . The ratio of the height of the cones to the square root of the base area for both models is $H/(\pi ab)^{1/2} = 1.87$, where H is the height of the cone.

1683

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

AN INVESTIGATION OF A LOW-DRAG AUXILIARY BODY UTILIZING FAVORABLE INTERFERENCE, by A. Martellucci. [1959] [3]p. incl. illus. diagrs. table. (AF 49(638)217) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 539-540, Aug. 1959.

Interference principles utilizing linearized flow techniques have been employed for the optimum replacement of bodies to the underside of a configuration so that, for a given lift of the system, the drag changes in such a manner that the L/D increases. The present investigation considers the placement of a body of large volume to the underside of a wing or fuselage, flying at a Mach number of 3.09, such that for a constant lift of the system, the additional wave drag will theoretically be zero. Since the body ducts air internally, it could be used as a ramjet engine to be used during the acceleration phase of flight, then cut out at design speed and carried along with only a small penalty in drag.

1684

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

STRESS DISTRIBUTION IN BEAMS OF THIN-WALLED SECTIONS IN THE PRESENCE OF CREEP, by S. A. Patel and K. A. V. Pandalai. Feb. 1959 [36]p. incl. diagrs. tables. (PIBAL rept. no. 486) (AFOSR-TN-59-174) (AF 49(638)302) AD 211314; PB 140062 Unclassified

The bending and shear stress distribution in beams of thin-walled sections in the presence of creep were investigated. The elastic analog is used to reduce the creep problem to a problem in non-linear elasticity. The cross-sections investigated are open sections with an axis of symmetry. As examples, channel sections, T-sections and lipped-angle sections are considered. Plots and tables indicating the effect of temperature on the location of the neutral axis and shear center for the channel section are presented. Thin-walled circular shells with and without stringer reinforcement are also treated and the effect of stringers on the bending and shear stress distribution is shown. (Contractor's abstract)

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Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A NOTE ON SHEAR CENTERS OF THIN-WALLED CLOSED SECTIONS IN THE PRESENCE OF CREEP, by K. A. V. Pandalai and S. A. Patel. Feb. 1959 [22]p. incl. diagrs. tables. (PIBAL rept. no. 487) (AFOSR-TN-59-190) (AF 49(638)302) AD 211311; PB 140060
Unclassified

This research has been concerned with the shift of shear centers of beams of thin-walled closed sections subjected to creep. The elastic analog helps reduce the creep problem to one of nonlinear elasticity. The examples considered are D-section, triangular section and an idealized airfoil section. All the cross sections considered are assumed to have one axis of symmetry. The results indicate that in the presence of creep the shear center can shift significantly from its position corresponding to the linear, elastic theory.

1686

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

HIGH ORDER CORRECT DIFFERENCE SCHEMES FOR MULTI-DIMENSIONAL PARABOLIC EQUATIONS, by J. R. M. Radok and K. Wang. Mar. 1959, 12p. (PIBAL rept. no. 492) (AFOSR-TN-59-329) (AF 49(638)302) AD 213676; PB 140532
Unclassified

A method of construction of high order correct difference schemes for multi-dimensional diffusion equations is developed which represents a natural generalization of a method, developed previously for the corresponding 1-dimensional equation. These difference formulas contain weighting coefficients with the 1-dimensional divided differences in several space dimensions which will ensure optimum truncation errors for a given number of base points. It is shown that these coefficients can be expressed in terms of their 1-dimensional counter parts. The response of these and certain 1-dimensional schemes to a certain mode of numerical solution is investigated for which the values of the dependent variable at adjacent points in space and time are of equal magnitude and of opposite sign. It is shown that for explicit schemes involving the mesh ratio $R = \frac{k}{h^2}$ linearly there is always a real value of R for which the selected mode separates the stable and unstable regime, while the 2nd-order explicit formulas involving R^2 are stable for all R. (Contractor's abstract)

1687

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

CREEP BEHAVIOR OF COLUMNS, by S. A. Patel and

B. Venkatraman. May 1959 [84]p. incl. diagrs. tables, refs. (PIBAL rept. no. 422) (AFOSR-TN-59-530) (AF 49(638)302) AD 216537
Unclassified

Investigation of the creep behavior of pin-ended columns is discussed. The analyses are carried out on the basis of an assumed equivalent I-section. Viscous and visco-elastic columns are considered first. The analysis is then carried out with the inclusion of a term to account for plastic deformations. Next, short-time buckling is investigated on the basis of a proposed transient creep law. Solutions for the critical time are presented in all cases. Finally, the validity of the assumptions made during the analysis is examined. It is shown that results in good approximation may be obtained with the use of an equivalent I-section and the neglect of higher harmonic deflection components. (Contractor's abstract)

1688

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

CREEP BUCKLING OF CYLINDRICAL SHELLS SUBJECTED TO UNIFORM AXIAL COMPRESSION, by F. W. French and S. A. Patel. May 1959 [18]p. incl. diagrs. (PIBAL rept. no. 489) (AFOSR-TN-59-538) (AF 49(638)302) AD 215555; PB 243007
Unclassified

The axially symmetric creep buckling of a circular cylindrical shell is investigated. A sandwich shell analogy and a biaxial creep law are used in the analysis. Two simultaneous, nonlinear differential equations are found to govern the stress distribution in and the displacement of the cylinder. A numerical example using these equations is carried out, and the results are presented in the form of curves. (Contractor's abstract)

1689

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

CREEP-STRESS ANALYSIS OF THIN-WALLED STRUCTURES, by S. A. Patel, K. A. V. Pandalai, and B. Venkatraman. July 1959 [40]p. incl. diagrs. tables, refs. (PIBAL rept. no. 497) (AFOSR-TN-59-665) (AF 49(638)302) AD 220049
Unclassified

Also published in Jour. Roy. Aeronaut. Soc., v. 64: 673-682, Nov. 1960.

A presentation is made of some methods of stress analysis of thin-walled structures subject to creep. It is assumed that the structures considered are maintained at a uniform temperature so that no thermal stresses are present. It is also assumed that the elastic deformations are negligible in comparison with creep deformations. Under these assumptions, the creep problems of thin-walled structures are first reduced to analogous problems of the same structures

AIR FORCE SCIENTIFIC RESEARCH

made of nonlinear elastic materials. The stress analyses are then carried out with particular reference to structures with closed and open cross sections and subjected to pure torsion, bending, and shear. (Contractor's abstract)

1690

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

ON THE DIFFRACTION OF AN ARBITRARY PULSE BY A WEDGE OR A CONE, by L. Ting. Feb. 1959 [12]p. incl. diags. (PIBAL rept. no. 502) (AFOSR-TN-59-127) (AF 49(638)445) AD 210615; PB 140643
Unclassified

Also published in Quart. Appl. Math., v. 18: 89-92, Apr. 1960.

By virtue of Green's theorem, it is shown that for the diffraction of an arbitrary 2-dimensional incident pulse by a wedge of angle μ , the ratio of the resultant velocity potential to the corresponding value of the incident pulse at the corner of the wedge at any instant is equal to $2\pi/(2\pi - \mu)$; and that for the diffraction of a 3-dimensional pulse by a cone of solid angle ω , the ratio at the vertex of the cone is equal to $4\pi/(4\pi - \omega)$. (Contractor's abstract)

1691

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

FAVORABLE INTERFERENCE OF A BODY AND BIPLANE COMBINATION IN SUPERSONIC FLOW, by L. Ting. Mar. 1959 [9]p. incl. diags. table. (PIBAL rept. no. 510) (AFOSR TN-59-200) (AF 49(638)445) AD 211526; PB 140028
Unclassified

An optimum contoured prismatic body mounted on a triangular midwing is compared with the combination of the same body with a biplane arrangement of a triangular high wing and low wing. For the same lifting surface, the span of the wings of the second combination is one-half of that of the midwing. The second configuration is favorable from a structural point of view and from the aerodynamic point of view. For the special configurations considered in the numerical example, a reduction of 8% in drag for the same lift is found for the biplane-body combination as compared with the monoplane-body combination. (Contractor's abstract)

1692

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

INVESTIGATION OF THE HEAT TRANSFER AND

PRESSURE DISTRIBUTION FOR SEVERAL SHOCK GENERATORS (Unclassified title), by V. Zakkay and D. A. MacKenzie. Apr. 1959. 27p. incl. illus. diags. table. (PIBAL rept. no. 460) (AFOSR-TN-59-328) (AF 49(638)445) AD 306306
Confidential

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Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

AN EXPERIMENTAL INVESTIGATION OF THE REDUCTION OF AERODYNAMIC HEATING TO A 15° AND 20° BLUNTED CONE AT $M_\infty = 6$ AND 8, by V. Zakkay. Feb. 1960, 39p. incl. illus. diags. (PIBAL rept. no. 469) (AFOSR-TN-59-350) (AF 49(638)445) AD 223662; AD 315691
Declassified

Data for the laminar and turbulent heat transfer and pressure distribution on a 15° and 20° blunted cone at a Mach number of 6 and 8 with several ring body configurations are presented. It is indicated that a larger reduction in the laminar heat transfer may be obtained as a result of increasing the Mach number. Effects of shock generator transition is investigated experimentally for a Mach number of 8 and a 15° blunted cone. It is indicated that the transition Reynolds number is affected by the presence of the shock generator. (Contractor's abstract)

1694

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

AN INVESTIGATION OF THE ADVANTAGEOUS USE OF INTERFERENCE EFFECTS IN THE DESIGN OF SUPERSONIC INLETS. PART III. EXPERIMENTAL RESULTS OF A SWEEPED, RECTANGULAR WING-ROOT INLET AT A MACH NUMBER OF 3.09 (Unclassified title), by A. Martellucci. Apr. 1959, 44p. incl. illus. diags. tables. (PIBAL rept. no. 511) (AFOSR-TN-59-351) (AF 49(638)445) AD 306305
Confidential

1695

Polytechnic Inst. of Brooklyn. [Dept. of Aeronautical Engineering and Applied Mechanics] N. Y.

ON THE TURBULENT FLOW OF AN ELECTRICALLY CONDUCTING STREAM IN THE PRESENCE OF A MAGNETIC FIELD (Abstract), by L. G. Napolitano. [1959] [1]p. (AFOSR-TN-59-357) (AF 49(638)445) AD 213683
Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 204, Mar. 30, 1959.

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A study is reported of the turbulent boundary layer over a flat plate when the fluid is electrically conducting and a magnetic field is present. It is assumed that the fluid has constant properties and that linearization with respect to the magnetic Reynolds number is permissible. A suitable 2-layer model of the hydromagnetic turbulent boundary layer is then postulated and the energy transfer mechanism occurring therein is described. Solutions are obtained for 2-layers in terms of a "magnetic parameter" ξ , and are then joined by following an extension of the Clauser approach. Both the modified law of the wall and skin friction law are thus determined. The cases considered pertain to magnetic fields fixed relative to the plate and/or to the free stream. Solutions are given to within a 1st approximation in the magnetic parameter ξ and the corresponding results are presented and discussed.

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Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

INTERFERENCE OF BODY AND TRAILING EDGE VORTEX SHEET IN SUPERSONIC FLOW, by S. Kobayakawa and L. Ting. May 1959, 27p. incl. diagrs. (PIBAL rept. no. 516) (AFOSR-TN-59-453) (AF 49(638)-445) AD 215028; PB 142264 Unclassified

The interference of a wing with a circular cylindrical body is treated by the generalized integral relationship. It is shown that the integral equation is valid if the region ahead of the Mach plane contains a vortex sheet-like discontinuity surface. With this extension, the integral equation is applied to obtain an approximate solution to the pressure distribution on the body surface which lies in the domain of influence of the trailing edge in a manner similar to that employed for the dihedral and the wing-body interference problem. For the present problem, an alternate form of the integral relationship is derived so that the range of integration is substantially reduced. For the purpose of illustration, a triangular flat plate with a sonic leading edge and an unswept trailing edge is mounted as a high wing configuration on a prismatic body of rectangular cross section, and the pressure distribution on the body in the domain of influence of the trailing edge is obtained. (ASTIA abstract)

1697

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

SOME HEAT TRANSFER PROBLEMS IN HYPERSONIC FLOW, by A. Ferri. July 1959, 51p. incl. illus. diagrs. table, refs. (PIBAL rept. no. 473) (AFOSR-TN-59-806) (Sponsored jointly by Aeronautical Research Lab. and Air Force Ballistic Missile Div. under AF 33(616)6118 and Air Force Office of Scientific Research under AF 49(638)445) AD 237730; PB 143600 Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 5-8, 1959), N. Y., Pergamon Press, 1960, p. 344-377. (TR-56-108)

The curved shock waves associated with blunt bodies at hypersonic velocity produce large entropy gradients and therefore large shear flows which interact with the boundary layer. The effects of this shear flow are discussed for the case of axially symmetric and 2-dimensional flow fields and for low and high Reynolds number of flight. Approximate methods of heat transfer analysis are presented for the case of laminar boundary layer in the presence of a shear flow with a cold wall and in the case of zero pressure gradient. The effects of interaction between external flow and laminar turbulent heat transfer and/or the effect of shear flow on transition are presented. Results show that these are large effects and important for practical applications. (Contractor's abstract)

1698

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

AN EXPERIMENTAL INVESTIGATION AT $M = 3.09$ ON HEAT TRANSFER REDUCTION BY THE USE OF UPSTREAM PROBES, by A. Martellucci and M. Visich, Jr. Nov. 1959, 1v. incl. illus. diagrs. tables, refs. (PIBAL rept. no. 527) (AFOSR-TN-59-1167) (AF 49(638)445) AD 223559 Declassified

An experimental study of some aerodynamic effects of upstream probes on a tangent-ogive body of revolution is presented. In particular, the effect of the probes on the heat transfer to the body is considered. The spikes considered were blunted with a teardrop cross section. The length to spike-maximum diameter L/D_m ranged from 4.75 to 9.50. The tests were conducted at a Mach number of 3.09 with a corresponding test section

Reynolds number per foot of 3.37×10^7 . For a 10° angle of attack range, the static pressure over the ogive remained unchanged, independent of the spike configuration. A stagnation pressure level reduction of the fluid that wets the ogive surface was measured. This results in a lowered surface Mach number which corresponds to a heat transfer reduction. The spike with $L/D_m =$

4.75 produced the largest heat rate reduction. Results show that the presence of probes upstream of a tangent-ogive does not affect the drag of the body, but the skin friction and heat transfer to the ogive can be expected to diminish. (Contractor's abstract)

1699

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

A STUDY OF SIMILARITY TRANSFORMATIONS FOR

AIR FORCE SCIENTIFIC RESEARCH

THE EQUATIONS OF A TWO-DIMENSIONAL INCOMPRESSIBLE VISCOUS FLUID FLOW, by K.-S. Wan. Dec. 1959, 20p. (PIBAL rept. no. 537) (AFOSR-TN-59-1257) (AF 49(638)445) AD 231852, PB 145773
Unclassified

Similarity transformations to a laminar flow equation and the Navier-Stokes equation were obtained for 2-dimensional unsteady and steady flows in both cartesian and polar coordinates. These include those obtained previously in the boundary layer theory as special cases. The possibilities of applying these transformations to obtain solutions for unsteady and steady laminar boundary layer problems with external accelerated or decelerated, irrotational or rotational flows, and fixed or moving boundaries, are indicated. (Contractor's abstract)

1700

Polytechnic Inst. of Brooklyn. Dept. of Aeronautical Engineering and Applied Mechanics, N. Y.

SOME SIMILAR SOLUTIONS FOR INCOMPRESSIBLE LAMINAR BOUNDARY LAYER PROBLEMS, by K.-S. Wan. Dec. 1959, 28p. incl. refs. (PIBAL rept. no. 538) (AFOSR-TN-59-1303) (AF 49(638)445) AD 235799
Unclassified

Similar solutions to 3 types of laminar boundary layer problems are given in terms of known solutions. The 1st problem pertains to unsteady laminar boundary layer when the external irrotational flow is inversely proportional to a linear function of time, and varies linearly in the direction of the main flow. The related heat transfer solution with isothermal heated surface is indicated. The 2nd is the classical steady laminar boundary layer problem, but with the external irrotational flow given by $u_0(1 + bx)^m$. The last problem is concerned with similar solutions for the boundary layer interacting with external inviscid rotational flow. A similar solution is obtained when the external vorticity is constant, large or small, and the external velocity varies as $U_0(1 + bx)^{1/3} + \omega y$ or $U_0x^{-1/3} + \omega y$. The latter case may be considered as a simple shear flow over a wedge with half wedge angle $\frac{\pi}{4}$. (Contractor's abstract)

1701

Polytechnic Inst. of Brooklyn. Dept. of Chemistry, N. Y.

PHOTOREDUCTION OF DYES IN RIGID MEDIA. II. PHOTOREDOX PROPERTIES OF THIAZINE DYES, by B. Broyde and G. Oster. [1959] [5]p. incl. diagrs. table, refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)293 and Atomic Energy Commission under AT(30-1)2206)
Unclassified

Presented at meeting of the Phys. Chem. Div. of the Amer. Chem. Soc., Boston, Mass., Apr. 5-10, 1959.

Abstract published in 135th meeting of the Amer. Chem. Soc. Abstracts of papers, 1959, p. 58-R.

Thiazines undergo photoreduction to their leuco forms when incorporated into high viscosity glasses of polyhydroxy compounds. The rate of photoreduction is proportional to the square root of the diffusion coefficient suggesting a diffusion-controlled process in which stationary state conditions are not achieved. Illumination of highly concentrated dye glasses containing an added mild reducing agent yields an intermediate color which reverts to the original dye on softening the glass. This species is an entrapped dimer of the original dye. Near ultraviolet light irradiation of the leuco glass yields the normal dye and other colored species. In acid glasses a red form is produced and in basic glasses a yellow form is the result, both forms reverting to the leuco species on softening the glass. The ratio of red to blue forms increases when the viscosity of the medium is increased. These intermediate species are believed to be a semiquinone and a diradical, or a molecule in the triplet state entrapped in the rigid medium. (Contractor's abstract)

1702

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

NON-LINEAR THEORY OF COMBUSTION INSTABILITY. LIQUID PROPELLANT ROCKET MOTORS, by T. P. Torda and S. Z. Burstein. Dec. 1, 1958, 106p. incl. diagrs. refs. (Technical note no. PRL-TN-58-1) (AFOSR-TN-59-60) (AF 49(638)165) AD 209491, PB 139653
Unclassified

The state of the art of combustion instability and sealing of liquid propellant rocket motors is discussed. A new non-linear theory is developed applicable to non-steady, one-dimensional flows with mass and energy addition. The resulting differential equations are solved by the method of characteristics. The problem has been completely coded for computations on an IBM 704 electronic data processing machine. (Contractor's abstract)

1703

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

SOME NUMERICAL METHODS OF SOLUTION OF NON-LINEAR PARTIAL DIFFERENTIAL EQUATIONS ARISING IN THE ANALYSIS OF SUBSONIC FLOW SYSTEMS WITH MASS AND HEAT ADDITION, by W. A. Beardsley and H. Berger. Dec. 1, 1958, 76p. incl. diagrs. (Technical note no. PRL-58-2) (AFOSR-TN-59-79) (AF 49(638)165) AD 210139, PB 140036
Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Four finite difference methods of solution are discussed for a system of three simultaneous partial differential equations which describe a one dimensional non-steady flow process with heat and mass addition which occurs in a rocket chamber. The partial differential equations are put into a finite difference form, and are used to calculate the variables (temperature, pressure, density, and velocity) throughout the x (position) - t (time) plane. (Contractor's abstract)

1704

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

AEROTHERMOCHEMISTRY OF JET PROPULSION LIQUID PROPELLANT ROCKET MOTORS, by T. P. Torda. Jan. 1959, 31p. incl. diagrs. refs. (Technical note no. PRL-59-3) (AFOSR-TN-59-80) (AF 49(638)-165) AD 210140; PB 139556 Unclassified

Discussion is presented on the following topics: aerothermochemistry of jet propulsion; combustion of liquid propellants; non-linear non-steady analysis of aerothermochemical phenomena in liquid propellant rocket motors; steady state operation - rocket chamber design; possible mechanisms for triggering instability; theories of rocket instability; and scaling of rocket motors.

1705

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

A NON-LINEAR NON-STEADY AEROTHERMOCHEMICAL ANALYSIS OF COMBUSTION INSTABILITY IN A ROCKET CHAMBER, by H. Berger. May 1, 1959, 76p. incl. diagrs. tables, refs. (Technical note no. PRL-TN-59-5) (AFOSR-TN-59-703) (AF 49(638)-165) AD 228733; PB 144500 Unclassified

The mathematical relations for describing the non-steady flow of a non-viscous gas are developed. The assumptions necessary to obtain an approximate quasi-one-dimensional system of equations are explained; suitable boundary conditions are given. The characteristic net used in obtaining the numerical solution of hyperbolic partial differential equations that is standard in gas dynamics is outlined, and its limitations with respect to the requirements of this analysis is discussed. A rigorous method of numerical integration of the non-steady equations, differing from the standard characteristic method common in gas dynamics analyses is examined. Its advantages are considered, and sample numerical calculations are presented.

1706

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

FLEXURAL VIBRATIONS OF ELASTIC SANDWICH PLATES, by Y.-Y. Yu. Mar. 1959 [30]p. incl. diagr. (Technical note no. 3) (AFOSR-TN-59-188) (AF 49(638)453) AD 211219; PB 140933 Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 272-282, Apr. 1960.

On the basis of the new flexural theory of elastic sandwich plates developed in two previous papers (PIB.15: 001, 002, Vol. II), which includes the effects of rotatory inertia and shear in the core and faces of the sandwich, and on the basis of the exact elasticity theory, flexural vibrations of infinite sandwich plates in plane strain are investigated. No limitations are imposed upon the magnitudes of the ratios between the thicknesses, material densities, and elastic constants of the core and faces of the sandwich. For ordinary sandwich plates that have relatively thin but heavy and rigid faces, the frequency equations may be reduced, and a numerical example is given. The results of the sandwich-plate theory show excellent agreement with those of the elasticity theory, and the former are shown to be applicable also to simply supported finite plates. It is concluded that the effects of rotatory inertia and shear play an even more important role in vibration studies of sandwich plates than in homogeneous plates. (Contractor's abstract)

1707

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

FORCED FLEXURAL VIBRATIONS OF SANDWICH PLATES IN PLANE STRAIN, by Y.-Y. Yu. July 1959, 22p. (Technical note no. 4) (AFOSR-TN-59-567) (AF 49(638)453) AD 235028; PB 146974 Unclassified

Published in Jour. Appl. Mech., v. 27: 535-540, Sept. 1960.

On the basis of newly-developed flexural theory of elastic sandwich plates, the problem of general forced flexural vibration of sandwich plates in the plane-strain case is solved. The classical method of separation of variables combined with the Mindlin-Goodman procedure (Jour. Appl. Mech., v. 17: 377-380, 1950) for treating time-dependent boundary conditions is used. As an example, the results are used in solving the problem of a simply supported sandwich plate in plane strain with 1 of the 2 end sections prescribed a transverse deflection varying with time. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

1708

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

SIMPLIFIED VIBRATION ANALYSIS OF ELASTIC SANDWICH PLATES, by Y.-Y. Yu. Aug. 1959, 24p. incl. table. (Technical rept. no. 5) (AFOSR-TN-59-1062) (AF 49(638)453) AD 234221; PB 146639

Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 894-900, Dec. 1960.

In a sequence of 3 recent papers a new flexural theory of elastic sandwich plates has been developed (see item nos. PIB.15:001, 002, Vol. II), and, on the basis of the theory, the flexural vibration of sandwich plates has been analyzed (see item no. 1706, Vol. III). The theory is good for a very wide frequency range that is of practical interest, but vibration analysis on the basis of the theory will in general be complicated due to the high order of the equations. For low frequency ranges simplified treatment of the vibration problem becomes possible and is discussed in this paper. Simpler equations of motion of sandwich plates are introduced, and their accuracy is determined by comparing them with the previous more complete equations. (Contractor's abstract)

1709

Polytechnic Inst. of Brooklyn. Dept. of Mechanical Engineering, N. Y.

A NEW THEORY OF SANDWICH PLATES. GENERAL CASE, by Y.-Y. Yu. Nov. 1959, 27p. (Technical note no. 6) (AFOSR-TN-59-1163) (AF 49(638)453) AD 234222; PB 146741

Unclassified

The 1-dimensional flexural case of a new theory of elastic sandwich plates was developed in 2 previous papers (item nos. PIB.15:001, 002, Vol II). The general 2-dimensional case of the theory is given in this paper. Extension as well as flexure is considered, and the core of the sandwich may be either isotropic or orthotropic. As the 1-dimensional case, the general theory is valid for any symmetrically arranged 3-layered plate and for vibration analysis involving wide frequency ranges. For sandwiches with very thin faces simplified equations good for limited frequency ranges are deduced. A brief discussion is given on sandwiches with cores composed of Kelvin-Voigt material. (Contractor's abstract)

1710

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

REFLEX MULTIPACTOR EFFECT, by B. Epsztein.

Sept. 22, 1959, 15p. incl. diagrs. (Rept. no. R-763-59; PIB-691) (AFOSR-TN-59-1103) (AF 18(600)1505) AD 228708; PB 149997

Unclassified

This paper is concerned with the theoretical study of a new type of multipactor which can take place on a single surface in the presence of a tangential dc magnetic field. The analysis shows that the presence of this effect depends only on the ratio of the cyclotron frequency corresponding to the applied magnetic field to the operating frequency, once a threshold for the r.f. field is reached. The value of this threshold depends on the secondary emission properties of the surface. Conditions for stable reflex multipactor are given. (Contractor's abstract)

1711

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

INVESTIGATION OF A CIRCULAR WAVEGUIDE PERIODICALLY LOADED WITH STRAIGHT WIRES, by M. Ettenberg and T. Tamir. Oct. 15, 1959 [13]p. incl. diagrs. refs. (Research rept. R-782-59; PIB-710) (AFOSR-TN-59-1298) (AF 18(600)1505) AD 230730; PB 152652

Unclassified

The investigation of the properties of a periodically loaded line is described. The line, consisting of a circular guide with straight wires loading, is shown to be suitable for linear accelerators and traveling-wave tubes. The determination of the propagation characteristic and other pertinent measurements is described. The results show that the structure exhibits a fundamental slow backward harmonic, similar to the properties of an anti-Karp line. A discussion on the influence of various parameters indicates how an appropriate propagation curve may be designed by suitable proportioning the geometrical dimensions of the structure. (Contractor's abstract)

1712

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

REALIZATION OF BOOLEAN POLYNOMIALS BASED ON INCIDENCE MATRICES, by S. Okada, Y. Moriwaki, and K. P. Young. Nov. 16, 1959 [37]p. incl. diagrs. tables, refs. (Research rept. R-790-59; PIB-718) (AFOSR-TN-59-1299) (AF 18(600)1505) AD 230765; PB 153234

Unclassified

An algebraic method for finding minimum switching 2-terminal networks for any given Boolean polynomial S is established by adopting node-branch incidence matrices as unknown quantities. Generators of invariant transformation group of S are determined. Prime implicant S_1 , or any other equivalent polynomial S_1 , are expressed by loops passing the relay branch and by a

AIR FORCE SCIENTIFIC RESEARCH

set of vectors $C_g(i)$ modulo 2 in a branch-number-dimensional affine space. Dually open circuit conditions R_i are expressed by a set of hyperplane covectors

$B^f(i)$ of cut-sets. $B^f(i)$ and $C_g(i)$ give realizable range of number of nodes, branches, and degree of freedom for each R_i and S_i . Base vectors $C_p(i)$ of subspace $C_g(i)$ and all vectors $C_k(i)$ which express loops passing the relay branch are determined based on linear dependency. Dually $B^f(i)$ gives base covectors $B^a(i)$ and all covectors $B^h(i)$ of cut-sets cutting the relay branch. Sneak paths or barriers in $B^h(i)$ or $C_k(i)$ are eliminated by increase of contacts. Networks of solution are obtained from either $B^a(i)$ or $C_q(i)$ by a new graphical or algebraic ambit-method, generally with addition of some pseudo-ties $C_n(i)$ which are loops including make and break contact of a relay in series.

Dually, pseudo-cuts $B^m(i)$ can be added to $B^a(i)$ for realization. (Contractor's abstract)

1713

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

PRELIMINARY DESIGN CONSIDERATIONS OF A MICROWAVE FLYWHEEL, by J. Griemsmann. Mar. 13, 1959, 13p. (Rept. no. 722; PIB-650) (AF 18(600)-1505) Unclassified

As a means of obtaining magnitudes of design parameters and indicating directions for future developments, preliminary designs of microwave "flywheels" are presented for ideal power magnifications of 5, 10 and 20 times, and for the standard rectangular copper waveguide in S, C, and X bands. An example of a realizable S-band design of final 4-fold power magnification is found to have a length of 135 ft, a build up time of 1.673 μ sec and a discharge time of .230 μ sec with an energy conversion efficiency of 44%. The inherent limiting factor, particularly for higher frequency designs, is found to be the attenuation of the waveguide used for the ring. A projected design using an oversized guide at C-band shows a power multiplication of 6.4 for a 537 ft ring, a build up time of 8.74 μ sec and a discharge time of .546 μ sec with an energy conversion efficiency of 41.3%. The length of the ring is, of course, directly associated with the desired duration of the output pulse and in addition specifies the requirements on the speed of switching required to discharge the ring. An appendix gives the analytical basis for the design including an heretofore unpublished solution for the transient build up of power in the ring. (Contractor's abstract)

1714

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

ON A CERTAIN PROBLEM IN QUEUEING THEORY WITH ARBITRARY PROBABILITY DISTRIBUTIONS OF THE NUMBER OF ARRIVALS AND SERVICING TIMES, by E. Mishkin. May 22, 1959, 7p. (Rept. no. 744; PIB-672) (AF 18(600)1505) Unclassified

The average queueing lengths and weighting times are derived for arbitrary probability distributions of the number of arrivals and of the processing times. The final expressions given are derived under certain conditions which govern the double integrations involved. (Contractor's abstract)

1715

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

NETWORK REPRESENTATIONS FOR MULTI-PATH LINE FILTERS, by E. N. Torgow. July 16, 1959, 13p. (Rept. no. 760; PIB-688) (AF 18(600)1505) Unclassified

Multi-path transmission line structures were investigated with a view toward the development of the necessary and sufficient conditions for network functions to be realized by the use of these structures. Cauer representation for the single line section was obtained. It was shown that the impedance matrix for the n-path transmission line network where all the path lengths are commensurate has a canonical Cauer network representation which consists of 2-port series connection of networks. The filter parameters, however, can be more readily observed from an examination of the image parameters of the n-path structure. Accordingly, the image parameters were derived and the characteristics of several 2-path line structures were examined. (Contractor's abstract)

1716

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

A FEEDBACK SYSTEM WITH CERTAIN UNUSUAL CHARACTERISTICS, by J. G. Truxal. Sept. 22, 1959, 6p. (Rept. no. 780; PIB-708) (AF 18(600)1505) Unclassified

The difficulty associated with the satisfactory design of even relatively simple feedback configurations on the basis of the theories so extensively developed for the single-loop system is illustrated by consideration of the characteristics of the system whose configuration involves only 3 simple negative feedback paths and 2 frequency-sensitive transfer functions. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

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Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

GENERAL N-PORT SYNTHESIS WITH NEGATIVE RESISTORS, by H. J. Carlin. Nov. 20, 1959, 4p. (Rept. no. 791: PIB-719) (AF 18(600)1505)

Unclassified

Also published in Proc. Inst. Radio Engineers, v. 48: 1174-1175, June 1960.

An n-port synthesis is presented for any $n \times n$ admittance $[Y(p)]$, impedance $[Z(p)]$, or scattering $[S(p)]$ matrix, in which the matrix elements are general rational functions with real coefficients containing zeros and poles of arbitrary multiplicity anywhere in the complex frequency (p) plane. It is shown that the synthesis can always be performed with passive elements (R, L, C, gyrators, ideal transformers) and negative resistors.

1718

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

A STABILITY CHARACTERIZATION OF THE GENERAL LINEAR, PASSIVE, RECIPROCAL, TIME-INVARIANT N-PORT, by D. C. Youla. Jan. 9, 1959, 15p. (Rept. no. 709; PIB-637) (AFOSR-4208) (AF 18-603)105

Unclassified

Also published in Proc. Inst. Radio Engineers, v. 47: 1150-1151, June 1959.

The fact that a 2 port which is reciprocal and stable under all passive terminations is passive has been known for quite some time. In the present work, it is shown that the theorem remains valid for arbitrary n-ports, i.e., a reciprocal n-port stable under all passive terminations is passive. The technique employed makes use of induction and the properties of mappings which transform the closed right half-plane into the open right half-plane. In addition, the scattering matrix $S(p)$ of the structure is assumed to be analytic and of "limited growth" in $\text{Re } p > 0$, no assumptions being made regarding its boundary behavior on $p = j\omega$. Thus, non-lumped networks fall within the scope of the theorem. (Contractor's abstract)

1719

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

BOUNDED REAL SCATTERING MATRICES AND THE FOUNDATIONS OF LINEAR PASSIVE NETWORK THEORY, by D. C. Youla, L. J. Castriota, and H. J. Carlin. [1959] [23]p. incl. refs. (AFOSR-4210) (AF 18-603)105 and AF 18(600)1505

Unclassified

Also published in I.R.E. Trans. on Circuit Theory, v. CT-6: 102-124, Mar. 1959.

The most general linear, passive, time-invariant n-port is studied from an axiomatic point of view, and a completely rigorous theory is constructed by the systematic use of theorems of Bochner and Wiener. An n-port Φ is defined to be an operator in H_n , the space of all n-vectors whose components are measurable functions of a real variable t , ($-\infty < t < \infty$). Under very weak conditions on the domain of Φ , it is shown that linearity and passivity imply causality. In every case, Φ_a , the

n-port corresponding to Φ augmented by n series resistors is always causal. Under the further assumptions that the domain of Φ_a is dense in Hilbert space

and Φ is time-invariant, it is proved that Φ possesses a frequency response and defines an $n \times n$ matrix $S(z)$ of a complex variable $z = \omega + i\beta$ with the following properties: (1) $S(z)$ is analytic in $\text{Im } z > 0$; and (2) $Q(z) = I_n - S^*(z)S(z)$ is the matrix of a non-negative

quadratic form for all z in the strict upper half-plane and almost all ω . Conversely, it is also established that any such matrix represents the scattering description of a linear, passive time-invariant n-port Φ such that the domain of Φ_a contains all of Hilbert space

Such matrices are termed "bounded real scattering matrices" and are a generalization of the familiar positive-real immittance matrices. When Φ and Φ^{-1} are single-valued, it is possible to define 2 auxiliary positive-real matrices $Y(z)$ and $Z(z)$, the admittance and impedance matrices of Φ , respectively, which either exist for all z in $\text{Im } z > 0$ and almost all ω or nowhere. The necessary and sufficient conditions for an $n \times n$ matrix $A_n(z)$ to represent either the scattering or immittance description of a linear, passive, time-invariant n-port Φ are derived in terms of the real frequency behavior of $A_n(\omega)$. Necessary and sufficient conditions for Φ_a to admit the representation

$$i(t) = \int_{-\infty}^{\infty} dW_n(\tau) e(t - \tau)$$

for all integrable $e(t)$ in its domain are given in terms of $S(z)$.

1720

Polytechnic Inst. of Brooklyn. Microwave Research Inst., N. Y.

GENERAL ELECTRONIC WAVEGUIDES, by N. Marcuvitz. Oct. 28, 1958, 25p. incl. illus. (Rept. no. R-692-58; PIB-620) (AFOSR-TN-59-115) (AF 49(638)-340) AD 210400

Unclassified

Published in Proc. Symposium on Electronic Waveguides, Polytechnic Inst. of Brooklyn, N. Y. (Apr. 8-10, 1958), N. Y., Interscience Publishers, 1958, p. 63-87.

For abstract see item no. PIB.09:029, Vol. II.

AIR FORCE SCIENTIFIC RESEARCH

1721

Pomona Coll. [Dept. of Physics] Claremont, Calif.

ULTRASOFT X-RAY INTERACTION COEFFICIENTS, by B. L. Henke and J. C. Miller. Aug. 1959, 1v. incl. diagrs. tables. (Technical rept. no. 3) (AFOSR-TN-59-895) (AF 49(638)394) AD 229780 Unclassified

Also published in Proc. Second Internat'l. Symposium on X-ray Microscopy and X-ray Microanalysis, Stockholm (Sweden) (1959), New York, Elsevier, 1960, p. 10-29.

Ultrasoft x-radiations (10-100A in wavelength) are highly absorbed by matter so as to be particularly useful in microanalysis. Photoelectric cross-sections may be interpolated from universal absorption functions and used to deduce the transitional probabilities for a particular atom which in turn allow the evaluation of the quantum dispersion equations for the atomic scattering factors. Universal tabulated functions have been obtained in this manner for the atomic scattering factors. It is noted that this approach is particularly appropriate and precise for the ultrasoft region for which the ratio of the atomic diam to the wavelength is very small and thus only dipole interactions are effective. Atomic scattering factors have been tabulated for O, Al and Si; refractive indices have been obtained for Al, Al_2O_3 , and SiO_2 ; and the reflected intensities from surfaces of Al, Al_2O_3 and SiO_2 and from layered combinations of these surfaces have been tabulated as a function of both wavelength and angle of reflection. These results have been used to illustrate the potentiality of ultrasoft x-radiations for application to the microanalysis for mass, chemical and surface structure information. (Contractor's abstract)

1722

Princeton U. Dept. of Aeronautical Engineering, N. J.

RESEARCH ON LAMINAR AND TURBULENT BOUNDARY LAYERS AND TRANSITION AT SUPERSONIC SPEEDS. Final rept. Nov. 14, 1952-Sept. 15, 1958, 9p. incl. refs. (AFOSR-TR-59-17) (AF 18(600)498) AD 264408 Unclassified

A summary is given of the major programs which have been carried out and some notes on unfinished work which did not show sufficient results for publication. A list of reports and published papers are included.

1723

Princeton U. [Dept. of Aeronautical Engineering] N. J.

NOTE ON THE SHOCK-INDUCED UNSTEADY LAMINAR

BOUNDARY LAYER ON A SEMI-INFINITE FLAT PLATE, by S. H. Lam and L. Crocco. [1959] [3]p. incl. diagr. (AF 18(600)498) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 54-56, Jan. 1959.

Let a semi-infinite flat plate be immersed in a quiescent gas of infinite extent and let its leading edge be the origin of a coordinate system (x, y) with the plate occupying the positive x-axis. A plane shock wave perpendicular to the x-axis, advancing in the positive x direction with constant velocity U_s , reaches the leading

edge of the plate at the instant $t = 0$. For $t > 0$, the shock travels over the plate. A boundary layer will develop on the plate between the leading edge and the moving shock. The gas velocity behind the shock is denoted by u_0 , and the strength of the shock is characterized by the number A which is the ratio of the shock velocity U_s to u_0 . The purpose of this note is to study this unsteady boundary layer under the following assumptions: (1) The boundary layer is laminar, (2) the boundary-layer approximations are valid, (3) the plane shock remains plane, (4) $\rho\mu = \text{constant}$, and (5) $P_r = \mu c_p / k = \text{constant}$.

1724

Princeton U. Dept. of Aeronautical Engineering, N. J.

A STUDY OF HYPERSONIC WINGS AND CONTROL, by S. M. Bogdonoff and I. E. Vas. [1959] [26]p. incl. refs. [IAS rept. no. 59-112] (AF 18(600)498) Unclassified

To facilitate study of hypersonic gliding and re-entry flight, experiments were made on single wings at Mach numbers between 11 and 12 in the Princeton Helium Hypersonic Tunnel, with emphasis on effect of sweep angle and angle of attack on pressure distribution. No correlation was found with geometrical theories (normal Mach numbers) but simple empirical relations were derived. Lift and moment of such wings deviate widely from such simple approximations as Newtonian flow.

1725

Princeton U. Dept. of Aeronautical Engineering, N. J.

THE STABILITY OF PROPELLANTS AND THE THEORY OF THERMAL IGNITION, by I. Glassman. May 1959, 19p. incl. diagrs. refs. (Rept. no. 460) (AFOSR-TN-59-586) (AF 18(600)1527) AD 217185; PB 142016 Unclassified

The concept of stability is investigated by considering the fundamentals of the stability process in light of the theory of thermal ignition. The stationary and

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non-stationary theories of thermal explosion are analyzed mathematically. From the conditions described, a propellant may be less stable than another for one test, but this relative stability rating may be reversed completely for another test where a different time-temperature domain exists. For 2 propellant systems having the same activation energy, the more energetic system will be the more unstable when all other factors are kept the same. However, it is not necessarily true that all propellant systems have the same activation energy. A very energetic system with a high activation energy can be more stable in the low-temperature regions than a low-energetic system with a low activation energy. One single test cannot be used to rule out a propellant on stability grounds. A propellant should be evaluated on the basis of many different tests and on the consideration for the over-all system in which the propellant is to be used. Thus, if hydrodynamic shock cannot exist in a given system, but long term small temperature rises can, a propellant which is very poor by card gap standards may be better than a propellant excellent in all tests except thermal stability.

1726

Princeton U. Dept. of Aeronautical Engineering, N. J.

FURTHER STUDIES ON THE LIGHT SCATTERING TECHNIQUE FOR DETERMINATION OF SIZE DISTRIBUTIONS IN BURNING SPRAYS, I, by R. A. Dobbins, L. Crocco, and I. Glassman. Apr. 10, 1959, 37p. incl. diagrs. table, refs. (Rept. no. 463) (AFOSR-TN-59-700) (AF 18(600)1527) AD 220496; PB 143022

Unclassified

The importance of measuring the droplet size distribution in rocket motors in order to determine the effect of the significant physical and chemical parameters on the combustion process has long been evident. To date no satisfactory technique has been developed for the direct measurement of droplet size distributions of a burning or evaporating stream. The light scattering technique appears to offer the possibility of accomplishing this purpose and the development of this technique could be a major contribution to the combustion field in its own right. Early theoretical and experimental work in light scattering by spherical particles is re-examined and inconsistencies are pointed out. A revised no-multiple-scattering theory is offered which correctly predicts various limiting cases and repetition of earlier experimental work is in order. The experimental considerations limiting the size of the particles which can be measured are discussed and it is estimated that the technique can be extended to include particles of the sizes formed in combustion chambers by injectors and atomizers. The possible adverse effects of scattering due to the presence of thermal gradients present in combustors is considered. Experimental equipment which has been built to measure small-angle scattering is described. (Contractor's abstract)

1727

Princeton U. Dept. of Aeronautical Engineering, N. J.

METAL COMBUSTION PROCESSES, by I. Glassman. Aug. 1959, 37p. incl. diagrs. tables, refs. (Rept. no. 473) (AFOSR-TN-59-1093) (AF 18(600)1527) AD 228566; PB 145531

Unclassified

Presented at Fourteenth annual meeting of the Amer. Rocket Soc., Washington, D. C., Nov. 16-20, 1959.

Since the light metallic elements undoubtedly will play a greater and greater role as propellants in advanced chemical and nuclear-chemical propulsion systems, interest in their burning characteristic is increasing. Some preliminary conclusions on burning characteristics are presented. These conclusions are based on fundamental physical considerations and not on experimental results. An analytical approach to calculate the burning rate of metals is also suggested. This approach differs from the diffusion-droplet approach in that it includes radiation feed-back and loss terms. Such terms can be important at the high temperatures of the diffusion film surrounding a burning metal. The verification of many of the postulates given in this report can be carried out ideally at some later date on the high pressure double rocket motor flow reactor developed under the subject contract. (Contractor's abstract)

1728

Princeton U. [Dept. of Aeronautical Engineering] N. J.

NEWTONIAN FLOW THEORY IN HYPERSONIC AERODYNAMICS, by W. D. Hayes. [1958] [7]p. incl. diagrs. tables. [AF 49(638)465]

Unclassified

Presented at First Internat'l. Cong. for the Aeronaut. Sciences, Madrid (Spain), Sept. 8-13, 1958.

Also published in *Advances in Aeronaut. Sciences*, v. 1: 113-119, 1959.

A brief description is given of the body of theory known as Newtonian flow theory, the theory based on the assumption that the shock layer in a hypersonic flow is infinitesimally thin. The reasons why the study of this theory is essential to an understanding of hypersonic aerodynamics are emphasized. The accomplishments of Sir Issac Newton in gas dynamics are discussed, together with the development of the pressure laws referred to as Newtonian. Some of the features of the general theory are discussed, including optimum shapes for minimum drag and solutions with cross flow. (Contractor's abstract)

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Princeton U. Dept. of Aeronautical Engineering, N. J.

INTERACTION OF A TWO-DIMENSIONAL INVISCID INCOMPRESSIBLE JET FACING A HYPERSONIC STREAM, by S. H. Lam. Mar. 1959 [31]p. incl. diagrs. (Rept. no. 447) (AFOSR-TN-59-274) (AF 49(638)465) AD 212708; PB 146018
Unclassified

A modified Newtonian pressure formula on the jet-shock layer interface is adopted in this report, and several assumptions are made regarding this formula as follows: (1) it is valid only for steady flow; (2) the jet flow is inviscid incompressible, and irrotational (the Laplace equation is established as the governing equation); (3) the problem is 2-dimensional; and (4) the total pressure of the jet equals the P_∞ when the jet is directly opposed to the oncoming stream. Within the framework of the above assumptions, it is demonstrated that any potential flow - hypersonic flow interaction problem may be treated if the stream lines of the potential flow can readily be drawn on the hodograph plane.

1730

Princeton U. Dept. of Aeronautical Engineering, N. J.

APPROXIMATE SOLUTIONS FOR SUPERSONIC FLOW OVER WEDGES AND CONES, by A. G. Hammit and K. R. A. Murthy. Apr. 1959 [19]p. incl. diagrs. (Rept. no. 449) (AFOSR-TN-59-304) (AF 49(638)465) AD 213088; PB 146007
Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 71-73, Jan. 1960.

Approximate solutions for the supersonic flow of a gas at relatively high Mach numbers over wedges and cones are presented. These methods provide simple and accurate results over a wide range of Mach number and specific heat ratios. (Contractor's abstract)

1731

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE NEWTONIAN THEORY OF HYPERSONIC FLOW FOR A BLUNT BODY, by N. C. Freeman. May 1959, 13p. (Rept. no. 467) (AFOSR-TN-59-634) (AF 49(638)465) AD 220140
Unclassified

The Hayes-Serbin theory of Newtonian hypersonic inviscid flow past blunt bodies is derived by a formal expansion procedure in powers of $(\gamma - 1)/(\gamma + 1)$. The theory is shown to be a uniformly valid extension of the Newtonian hypersonic flow past blunt bodies. Particular attention is given to the solution to the flow past a sphere where the original bluff body result is shown to be valid in the neighborhood of the stagnation point. (Contractor's abstract)

1732

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON A SINGULAR POINT IN THE NEWTONIAN THEORY OF HYPERSONIC FLOW, by N. C. Freeman. May 1959 [28]p. incl. diagrs. tables, refs. (Rept. no. 466) (AFOSR-TN-59-635) (AF 49(638)465) AD 220139
Unclassified

Also published in Jour. Fluid Mech., v. 8: 109-122, May 1960.

An examination of the Newtonian inviscid theory of hypersonic flow past a sphere is made in the neighborhood of the singular point which occurs at $\Theta = 60^\circ$. A uniformly valid theory is developed in this neighborhood which exhibits the limiting detached "free layer" behavior postulated by Hayes and Lighthill in the limit as $\gamma \rightarrow 1$. A complete solution is obtained which gives details of streamline and shock wave shape, pressure distribution, etc., for $(\gamma - 1)$ small. Reasons are given why this theory suggests that the empirical "modified" Newtonian theory of Lees. (Hypersonic Flow, IAS Preprint no. 554, 1955) proves to be good approximation to experimentally determined pressure distributions. A novel check to the theory is provided by a simple power law relation between the pressure on the sphere surface and the distance of the shock wave away from sphere at the same point. (Contractor's abstract)

1733

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE LIMITING STRUCTURE OF THE EDGE OF A HYPERSONIC BOUNDARY LAYER WITH VERY COLD FREE STREAMS, by N. C. Freeman and S. H. Lam. May 1959 [23]p. incl. diagrs. tables. (Rept. no. 468) (AFOSR-TN-59-690) (AF 49(638)465) AD 240233; PB 149753
Unclassified

The structure of the edge of a hypersonic boundary layer in the limit of zero free stream temperature is analyzed with conventional boundary layer approximations for a gas with arbitrary Prandtl number Pr and viscosity law $\mu \propto T^s$. It is shown that for certain combinations of Pr and s the velocity profile has a discontinuity in slope at the edge of the boundary layer. The boundary layer thickness in this limit is always finite for $S > -1$. For $S < -1$ no limiting solution exists for any Pr . (Contractor's abstract)

1734

Princeton U. Dept. of Aeronautical Engineering, N. J.

HEAT TRANSFER THROUGH A REGION OF CLOSED-STREAMLINE, by S. H. Lam. May 1959, 22p. (Rept. no. 469) (AFOSR-TN-59-727) (AF 49(638)465)
Unclassified

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It has been shown that the pertinent parameter in this class of problem is the Peclet number $\lambda = R_e P_r$. Since this number contains a characteristic length, the solution is not invariant with respect to a scale transformation. When λ is small, the solution tends to the simple conduction solution, which is invariant with respect to a scale transformation. For any $\lambda > 0$ and for any steady flow pattern, the gross heat transfer rate through the region is always higher than Q_0 . For small λ , the increase of gross heat transfer rate is proportional to λ^2 . For large λ , the gross heat transfer rate is proportional to $\lambda^{1/3}$. Both results are for $\Phi = 0$ only. Dissipation in the region will, in general, increase the heat transfer rate through the cold boundary and decrease the heat transfer rate through the hot boundary. (Contractor's abstract)

1735

Princeton U. Dept. of Aeronautical Engineering, N. J.

ON THE MACH NUMBER INDEPENDENCE PRINCIPLE FOR A HYPERSONIC BOUNDARY LAYER, by N. C. Freeman and S. H. Lam. July 1959, 13p. (Rept. no. 471) (AFOSR-TN-59-728) (AF 49(638)465) AD 233046; PB 157732 Unclassified

The Mach number independence principle for a hypersonic viscous boundary layer postulated by Hayes and Probstein is considered for the case of a flat plate with no heat transfer. The structure of the boundary layer is given, and the transition solution in the neighborhood of the edge of the boundary layer is constructed. This transition layer, in which the boundary layer adjusts to the free stream conditions, is shown to have a thickness scale proportional to $(M_\infty)^{-1/5}$ as originally suggested. The values of density, temperature and velocity across this layer are determined explicitly in terms of velocity and implicitly in terms of velocity and implicitly as functions of boundary layer coordinates. (Contractor's abstract)

1736

Princeton U. Dept. of Aeronautical Engineering, N. J.

NUMERICAL SOLUTIONS OF SHOCK-INDUCED UNSTEADY BOUNDARY LAYERS, by S. H. Lam. Aug. 1959 [37]p. incl. diagrs. tables. (Rept. no. 480) (AFOSR-TN-59-926) (AF 49(638)465) PB 147265 Unclassified

This report is a supplement to PRI.04:023, Vol. II. Numerical solutions for the shear function $\Phi(\alpha, \beta)$ and the Reynolds analogy coefficient (Ra) are presented. The calculations were performed on the Wright Field Univac Scientific 1103 digital computer using the Wright Field "CHIP" interpretive system. It was found that the iteration procedure suggested in the above report was suc-

cessful in generating solutions of good accuracy for the shear function $\Phi(\alpha, \beta)$. However, because of the lack of a suitable "momentum integral correction" procedure, the iteration for the enthalpy function $H(\alpha, \beta)$ was found to be unsatisfactory. (Contractor's abstract)

1737

Princeton U. [Dept. of Aeronautical Engineering] N. J.

COMBUSTION INSTABILITY IN SOLID ROCKETS USING PROPELLANTS WITH SUSPENDED METALLIC POWDERS, by S.-I. Cheng. Sept. 1959 [32]p. (Rept. no. 482) (AFOSR-TN-59-1002) (AF 49(638)465) AD 231172; PB 157720 Unclassified

Also published in Proc. First Internat'l. Symposium on Rockets and Astronautics, Tokyo (Japan) (May 25-28, 1959), Tokyo, Yokendo, 1960, p. 62-73.

The stability of the acoustic oscillations in the chamber of a solid propellant rocket is analyzed to reveal the effect of the addition of the metallic powders to a basic solid propellant. The dissipative action of the oscillation of the particles in the condensed phases is neglected. The oxidation of the metallic powders is considered as distributed heat sources to the gas system. The heat addition distorts the acoustic field through the variation of the speed of sound over the chamber volume. This modifies the non-dissipative damping action of the supercritical nozzle. The rate of heat release from the metallic powders may fluctuate but lag behind the local gas oscillation. This oscillatory heat source from the oxidation of the metallic powders, like the oscillatory mass source from the combustion of the basic propellant, can excite unstable oscillations of the gas system. The 2 exciting forces are, however, out of phase, in general, and may or may not counteract each other. (Contractor's abstract)

1738

Princeton U. Dept. of Aeronautical Engineering, N. J.

THE BOUNDARY LAYER IN A CORNER, by S.-I. Cheng and R. H. Levy. Nov. 1959 [45]p. incl. diagrs. tables, refs. (Rept. no. 485) (AFOSR-TN-59-1165) (AF 49(638)465) AD 232955; PB 157741 Unclassified

The problem of the incompressible boundary layer between 2 semi-infinite flat plates whose line of intersection is parallel to the incoming flow and whose leading edges are perpendicular to it is treated for arbitrary angle between the plates. A series expansion valid at small distances from the corner is developed; the 1st term is derived from consideration of the creeping flow in which convective forces are negligible compared to pressure and viscous forces. An asymptotic solution is obtained for the case when the angle between the plates is less than π ; it is based upon an estimate of the form of the flow in the transverse plane far from the corner which is generally non-vanishing

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in the boundary layer approximation. This solution is matched to the series solution for various values of the angle between the plates, and consistent numerical results are obtained. (Contractor's abstract)

1739

Princeton U. [Dept. of Aeronautical Engineering] N. J.

ON THE FLOW PAST A SPHERE AT HYPERSONIC SPEED WITH A MAGNETIC FIELD, by N. C. Freeman. [1959] [3]p. (AFOSR-4159) (AF 49(638)465)

Unclassified

Also published in Jour. Aero/Space Sci., v. 26: 670-672, Oct. 1959.

An explanation is given on the anomalies between the constant density solution to the hypersonic inviscid flow past a sphere with a radial magnetic field in a conducting fluid obtained by Kemp and the author's extension of the Newtonian theory of hypersonic flow to magnetic field problems. It is found that Kemp's result is incorrect as the 1st approximation in some expansion procedure vanishes, causing a singular behavior in the higher order terms. A scheme outlined by Lighthill for making such approximations uniformly valid is then developed. The result obtained is in agreement with that obtained from the Newtonian theory when a magnetic field and a conducting fluid are introduced.

1740

Princeton U. [Dept. of Aeronautical Engineering] N. J.

A NOTE ON THE EXPLOSION SOLUTION OF SEDOV WITH APPLICATION TO THE NEWTONIAN THEORY OF UNSTEADY HYPERSONIC FLOW, by N. C. Freeman. [1959] [2]p. (AFOSR-4160) (AF 49(638)465)

Unclassified

Published in Jour. Aero/Space Sci., v. 27: 77-78, Jan. 1960.

The Sedov solution of the equations of inviscid compressible unsteady flow is analyzed in the limiting form where the ratio of specific heats approaches zero. The Newtonian theory of unsteady flow is then developed and it is shown that the assumption of Newtonian theory that breaks down in the derivation of the constant-energy similarity solution of Sedov is that of isothermal conditions along particle paths. The Newtonian theory is able, by modification of this assumption alone, to give the correct non-uniform dependence in the limit as $\gamma \rightarrow 1$.

1741

Princeton U. [Dept. of Aeronautical Engineering] N. J.

VISCOUS HYPERSONIC SIMILITUDE, by W. D. Hayes

and R. F. Probst. [1959] [23]p. incl. diagrs. [IAS rept. no. 59-63] (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638) and Wright Air Development Center under AF 33(616)5442)

Unclassified

Presented at Twenty-Seventh annual meeting of the Inst. of Aeronaut. Sciences, New York, Jan. 26-29, 1959.

An extension of classical hypersonic similitude is developed which takes into account the interaction effect of the displacement thickness of the boundary layer. A basic result of this viscous similitude is that the total drag including frictional drag obeys the classical similarity law for the pressure drag. Additional similarity conditions governing viscous effects must be imposed in this similitude. Underlying the similitude is a new hypersonic boundary layer independence principle. According to this principle, the principal part of a hypersonic boundary layer with given pressure and wall temperature distributions and free stream total enthalpy is independent of the (high) external Mach number distribution outside the boundary layer. Various features of viscous hypersonic similitudes are discussed. It is found, for example, that it applies to three-dimensional boundary layer interaction effects on flat bodies provided the concepts of strip theory may be applied and provided the aspect ratio is an invariant. (Contractor's abstract)

1742

Princeton U. Dept. of Chemistry, N. J.

CHEMICALLY INDUCED VIBRATIONAL EXCITATION: HYDROXYL RADICAL EMISSION IN THE 1-3 MICRON REGION PRODUCED BY THE $H + O_3$ ATOMIC FLAME,

by D. Garvin, H. P. Broida and H. J. Kostkowski. Aug. 24, 1959 [23]p. incl. diagrs. tables, refs. (Technical note no. 5) (AFOSR-TN-59-746) (In cooperation with National Bureau of Standards, Washington, D. C. CSO-680-56-30) (AF 18(603)134) AD 226573

Unclassified

Also published in Jour. Chem. Phys., v. 32: 880-887, Mar. 1960.

A detailed investigation was performed in the 1 to 3 μ wavelength region on the radiation emitted by the hydroxyl radical from a low pressure flame of ozonized oxygen and atomized hydrogen. Wavelengths and photon intensities were obtained for about 300 lines in the OH vibration-rotation bands $V \rightarrow V - \Delta V$ where $\Delta V = 3$, $V = 9$ to 5 and for $\Delta V = 2$, $V = 9$ to 2. Relative photon band intensities were determined from the overdetermined set of data by a method of successive approximations using an IBM-650 computer. Dipole moment parameters were calculated using the above data and Morse Oscillator transition probabilities. Approximate rotational and vibrational Boltzmann distributions exist with an average rotational "temperature" of 560°K for the P branches, 460°K for the R and Q branches and a vibrational "temperature" of 9250°K for the $\Delta V = 2$ and 3 bands. The

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absence of radiation from levels $V > 9$ confirms the non-thermal character of the excitation and its dependence on the energetics of the reaction $O_3 + H \rightarrow OH + O_2$.

Moreover, flux calculations based on the assumption that in this case collisional deactivation transition probabilities are proportional to the radiation probabilities show that there is an appreciable OH production in all levels $V \leq 9$, and the main flux of OH through any population level is via $\Delta V = 1$ transitions. Possible causes for the large changes in line intensity with pressure and smaller but significant changes with flows or concentrations are discussed. (Contractor's abstract)

1743

Princeton U. Dept. of Chemistry, N. J.

THE THERMAL OZONE-HYDROGEN REACTION, by T. P. Williams and D. Garvin. Sept. 15, 1959 [35]p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-59-979) (AF 18(603)134) AD 228326; PB 144019
Unclassified

The kinetics of the reaction between dilute ozone and molecular hydrogen has been studied in the temperature range 400-500°K using a flow technique. Water is the principal product, small amounts of hydrogen peroxide also are formed. The reaction competes with the thermal decomposition of ozone. It is concluded that the oxidation of hydrogen is initiated by oxygen atoms formed in the thermal decomposition of ozone, and that a short chain sequence occurs. Mechanisms involving either OH or both OH and HO_2 are presented. (Contractor's abstract)

1744

Princeton U. [Dept. of Mathematics] N. J.

THE THEORY OF CHARACTERISTIC CLASSES, by J. Milnor. [1959] 144p. incl. diagrs. refs. (AFOSR-TN-59-9) (AF 18(600)1494) AD 208281; PB 139634
Unclassified

Lectures are presented on the following topics: n-plane bundles; Stiefel-Whitney classes; Applications; Stiefel-Whitney numbers; Paracompactness; The cohomology ring $H^*(G_n, \mathbb{Z}_2)$; Existence of Stiefel-Whitney classes; Oriented bundles; Computations in differentiable manifolds; Obstructions; Complex n-plane bundles; Pontrjagin classes; Pontrjagin numbers; Corbordism; The index theorem; Combinatorial Pontrjagin classes.

1745

[Princeton U. Dept. of Mathematics, N. J.]

ON SEMISIMPLICIAL FIBRE-BUNDLES, by M. G. Barratt, V. K. A. M. Gugenheim, and J. C. Moore.

[1959] [19]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)-1494 and Office of Ordnance Research under DA 36-034-ORD-2588RD)
Unclassified

Published in Amer. Jour. Math., v. 81: 639-657, July 1959.

A study is made of semisimplicial fibre bundles and in order to show how general fibre bundles are. It is shown that a minimal fibre map is, in fact, the map of the total complex of a semisimplicial fibre bundle into the base complex. In the description of a semisimplicial fibre-bundle with fibre Y there occurs a certain group-complex $A(Y)$ or, more generally, one of its subgroups Γ ; the consequential notion "T-bundle" is the semisimplicial analogue of a Steenrod fibre bundle with structural group Γ . In particular the classical notions of the associated principal bundle and the classifying space reappear in theory.

1746

Princeton U. [Dept. of Mathematics] N. J.

OBSTRUCTIONS TO THE SMOOTHING OF PIECEWISE-DIFFERENTIABLE HOMEOMORPHISMS, by J. Munkres. [1959] [3]p. (AF 18(600)1494)
Unclassified

Published in Bull. Amer. Math. Soc., v. 65: 332-334, Sept. 1959.

A unification and extension within the framework of an obstruction theory of some of the results concerning Milnor and Thom's differentiable structures are presented. If M and N are diffeomorphic, then they are combinatorially equivalent; a partial converse of this is sought. An attempt is made to redefine f in neighborhoods of the open simplices of M. Thus f is no longer a linear isomorphism between C^2 triangulations. If $f: M \rightarrow N$ is a diffeomorphism mod L^{m-1} , an approximate f by a map $g: M \rightarrow N$ which is a diffeomorphism mod L^{m-1} can be sought. This method permits, among others, the demonstration of known results for the differentiable structures.

1747

Princeton U. [Dept. of Mathematics] N. J.

GENERAL ANALYTICAL SETTING FOR THE CENTRAL LIMIT THEORY OF PROBABILITY, by S. Bochner. [1959] [18]p. (AF 49(636)578)
Unclassified

Published in Bull. Calcutta Math. Soc. (Golden Jubilee Commemorative Volume), pt. 1: 111-128, 1958-1959.

Some first observations are presented on possibilities that can occur when the positive-definiteness is either

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relaxed or modified in a Fourier transform of a probability distribution. It is pointed out that the control limit theory is concerned with the behavior of a product of sufficiently many products each of which is sufficiently near to the unity function.

1748

Princeton U. Dept. of Mathematics, N. J.

GENERALIZED CONJUGATE AND ANALYTIC FUNCTIONS WITHOUT EXPANSIONS, by S. Bochner. [1959] [3]p. [AF 49(638)578] Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 45: 855-857, June 1959.

Complex-valued measurable functions are considered on a Lebesgue measure space with total measure finite or infinite. A theorem is presented which is an axiomatic generalization of a basic theorem of M. Riesz for functions on 1 variable, and the existence of finite bounds of the operator over the functions is established. A related Hausdorff space with a Borel measure is also considered and a theorem presented which is an axiomatization of a multi-variable version. Other theorems of these 2 are also discussed under the new assumptions.

1749

Princeton U. [Dept. of Mathematics] N. J.

ALGEBRAS OF HOLOMORPHIC FUNCTIONS ON ONE-DIMENSIONAL VARIETIES, by H. Rossi. Oct. 1959, 37p. incl. refs. (AFOSR-TN-59-1179) (AF 45(638)692) AD 231970; PB 145771 Unclassified

Also published in Trans. Amer. Math. Soc., v. 100: 439-458, Sept. 1961.

One-dimensional analytic spaces are studied with emphasis on the maximality problem of the algebra of holomorphic functions on a compact subset, first considered for Riemann surfaces by John Wermer (IAS.05:021, Vol. II). It is proven that this is the only case where such an algebra is maximal. Representations of subalgebras of holomorphic functions on Riemann surfaces as algebras on an analytic is also considered. (Contractor's abstract)

1750

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXIX. DIELECTRIC RELAXATION AND GROUP ROTATION IN SOME AROMATIC METHOXY COMPOUNDS, by D. M. Robert and C. P. Smyth. [1959] [5]p. incl. diagr. tables, refs. (AFOSR-TN-59-689) [AF 18(600)1331] Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2106-2110, May 5, 1960.

The effect on dielectric relaxation of rotation of the methoxy group has been studied by a series of measurements on anisole, o-dimethoxybenzene, m-dimethoxybenzene, p-dimethoxybenzene, 1-methoxynaphthalene, 2-methoxynaphthalene and p-chloroanisole. Comparison of these values with those for the analogs, where a methyl group has been substituted for each methoxy group, shows that the presence of a methoxy group causes a lowering of the relaxation time below the expected value. Two distinct dispersion regions were indicated for o-dimethoxybenzene, as might be expected for a molecular rotation and a methoxy group rotation. The value for 1-methoxynaphthalene is higher than that for 2-methoxynaphthalene because of the hindrance to rotation of the methoxy group of the 1-isomer by the hydrogen on the 8-carbon. Mutual viscosities have been determined for benzene solutions of o-dimethoxybenzene, p-dimethoxybenzene, 1-methoxynaphthalene, 2-methoxynaphthalene, p-chloroanisole and 1-nitronaphthalene. Reduced relaxation times of the liquids have been compared with the solution values reduced by the solvent viscosity and by the mutual viscosity. (Contractor's abstract)

1751

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXVIII. THE DIELECTRIC RELAXATION OF SOME RIGID MOLECULES IN VISCOUS SOLUTIONS, by O. F. Kaiman and C. P. Smyth. [1959] [5]p. incl. diagrs. tables, refs. (AFOSR-TN-59-729) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1331] and Office of Ordnance Research) AD 245262 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 783-787, Feb. 20, 1960.

The dielectric constants and losses at wave lengths of 1.25, 3.22, 10, 25 and 50 cm, and 300 m have been measured for d,l-camphor, isoquinoline and 4-bromobiphenyl in solution in a viscous oil, and for acridine in the oil and in decalin at 20, 40 and 60°. The Cole-Cole arc plots have been used to calculate the most probable dielectric relaxation times for the solutions and their distribution parameters. The effect of viscosity on relaxation time increases from the slight viscosity dependence for the nearly spherical camphor molecule to a considerable dependence for the elongated molecules. Over this same range of molecular shape the activation energy for dielectric relaxation increases from a small value for the nearly spherical molecule to a value close to that for viscous flow for the elongated molecules. Where there is a possibility of more than 1 relaxation time for a molecule, the highly viscous solvent tends to increase the separation or distribution of the times. (Contractor's abstract)

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Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXX. THE ANOMALOUS DIELECTRIC RELAXATION OF DIPHENYL ETHER AND SOME SIMILAR MOLECULES, by D. M. Roberti, O. F. Kalman, and C. P. Smyth. [1959] [4]p. incl. tables, refs. (AFOSR-TN-59-1224) (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)-1331] and Office of Ordnance Research) AD 245263
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 3523-3526, July 20, 1960.

Dielectric relaxation times have been determined for diphenylmethane, benzyl ether, bibenzyl and dibenzyl ether, as pure liquids, to be compared with previous values for diphenyl ether and benzophenone. All the measured compounds have relaxation times comparable to that for diphenyl ether, very low in comparison to that for benzophenone. In addition, the relaxation time of diphenyl ether measured in Nujol has been found to be relatively insensitive to viscosity and temperature. The results indicate that some form of intramolecular motion is responsible for the small relaxation time. Several previously proposed mechanisms are discussed. (Contractor's abstract)

1753

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXXI. ANALYSIS IN TERMS OF TWO RELAXATION TIMES FOR SOME AROMATIC ETHERS, by K. Bergmann, D. M. Roberti, and C. P. Smyth. [1959] [3]p. incl. diagr. tables, refs. (AFOSR-TN-59-1319) (AF 18(600)1331) AD 245263
Unclassified

Also published in Jour. Phys. Chem., v. 64: 665-667, May 1960.

Dielectric measurements on diphenyl ether, dibenzyl ether, anisole and o-dimethoxybenzene have been analyzed in terms of 2 relaxation times. The results are consistent with the interpretation of a large relaxation time due to molecular rotation and a smaller relaxation time due to intramolecular motion, notably methoxy group rotation for anisole and o-dimethoxybenzene. The data for dibenzyl ether have also been analyzed in terms of a distribution of relaxation times between 2 limiting values. (Contractor's abstract)

1754

Princeton U. Frick Chemical Lab., N. J.

DIELECTRIC INVESTIGATION OF POLAR MOLECULES IN LIQUIDS AND SOLIDS, by C. P. Smyth.

Final rept. Nov. 1, 1954-Dec. 31, 1958, 11p. incl. refs. (AFOSR-TR-59-22) (AF 18(600)1331) AD 211668; PB 139904
Unclassified

The limitations of the equations for the effect of the internal field upon molecular relaxation time have been established and the relation of the molecular to the macroscopic relaxation time has been found to depend on the shape of the molecule as well as on the dielectric constant of the liquid. An approximate proportionality between the relaxation time and the volume of a rigid molecule has been observed but the orientation of the dipole in a non-spherical molecule influences the relaxation time by determining the most probable axis about which the molecule may rotate, thus complicating the relationship. In pure polar liquids, the relaxation time is often roughly proportional to the viscosity but some increases in molecular volume which increase the relaxation times have little effect on the viscosities. In solutions, increase in solvent viscosity with increase in molecular size does not generally bring about a proportionate increase in the relaxation time of the polar solute molecule, although some increase is usually observed. This complexity of behavior prevents any of the several equations so far advanced for these phenomena from being generally valid. However, the observation of the deviations as well as the regularities provides valuable evidence of the mechanism of molecular behavior in liquids. The measurement of the dielectric constants and losses of liquids at 3.1 mm. wavelength extended such measurements to a higher frequency than any previously attained.

1755

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXVII. THE MUTUAL VISCOSITIES AND DIELECTRIC RELAXATION TIMES OF SEVERAL POLAR AROMATIC COMPOUNDS IN SOLUTION, by D. A. Pitt and C. P. Smyth. [1959] [4]p. incl. diagrs. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research under AF 18(600)1331] and Office of Naval Research) AD 248758
Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 783-786, Feb. 20, 1959.

The viscosities of dilute solutions of 7 polar solutes in 2 non-polar solvents have been measured at 20, 40 and 60°C, and the slopes of the viscosity-concentration plots have been used to calculate the mutual viscosities. The use of these values in an equation developed by Hill for the calculation of the relaxation times of the solutions gives values considerably higher than the observed. (Contractor's abstract)

1756

Princeton U. Frick Chemical Lab., N. J.

MICROWAVE ABSORPTION AND MOLECULAR

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STRUCTURE IN LIQUIDS. XXVI. THE DIELECTRIC RELAXATION TIMES OF TWO LARGE OBLATE ELLIPSOIDAL MOLECULES IN BENZENE SOLUTION, by D. A. Pitt and C. P. Smyth. [1959] [6]p. incl. diagrs. tables, refs. (Sponsored jointly by [Air Force Office of Scientific Research under AF 18(600)1331] and Office of Naval Research) AD 248759 Unclassified

Also published in Jour. Phys. Chem., v. 63: 582-587, Apr. 1959.

The dielectric relaxation times of metal-free hepta-phenylchlorophenyl-porphyraxine (I) and of ferric octa-phenylporphyraxine chloride (II) have been determined in benzene solution, based on dielectric constant data at 1.25, 3.22, 10.0, 25.0 and 50.0 cm wave lengths at temperatures of 20, 40 and 60°. The dipole moment of I lies in the plane of the great ring, while that of II is perpendicular to the molecular plane. The relaxation time of the former is close to that calculated by equations taking into account the microscopic viscosity. The ferric complex, with a relaxation time 5/2 that of I is better described by a relation involving the macroscopic solvent viscosity. It is evident that relaxation occurs through 2 different modes of orientation. A new dielectric measuring apparatus is described, consisting of a coaxial line resonant cavity. The transmission-line equations provide a simple derivation of the transmission of power through the cavity as a function of the cavity dimensions and of the dielectric properties of the liquid filling the cavity. The apparatus is usable over a wide frequency range and is especially applicable to measurements of the dielectric constant and loss of dilute solutions. (Contractor's abstract)

1757

Princeton U. James Forrestal Research Center, N. J.

SOME EFFECTS OF INTRAMOLECULAR VIBRATIONAL ENERGY TRANSFER IN COMPLEX FLUORESCENT MOLECULES, by B. Stevens. [1959] [6]p. incl. diagrs. refs. (AF 33(038)23976) Unclassified

Published in Canadian Jour. Chem., v. 36: 96-101, Jan. 1958.

The effects of intramolecular redistribution of vibrational energy on both the fate of an excited complex molecule and the appearance of its electronic spectra are discussed in terms of a 3-dimensional energy surface. It is suggested that continuous absorption be used as a criterion for the application of classical methods to intra- and inter-molecular vibrational energy transfer in those cases where fluorescence emission is observed. (Contractor's abstract)

1758

Princeton U. James Forrestal Research Center, N. J.

BASIC RESEARCH IN PHYSICAL AND CHEMICAL KI-

NETICS RELATED TO PROBLEMS OF COMBUSTION AND PROPULSION, by R. H. Wilhelm. Final rept. Nov. 4, 1959, 14p. incl. refs. (AFOSR-TR-59-174) (AF 33(038)23976) AD 231830; PB 145685

Unclassified

A summary of the research in physical and chemical kinetics conducted under this contract is presented. The work was concerned with the following topics: (1) High temperature flow kinetics of the hydrogen-bromine and/or hydrogen iodine reaction. (2) Kinetics and mechanisms of the decomposition of ammonium nitrate and various amine nitrates. (3) Energy exchange processes in molecular collisions. (4) Kinetics and mechanism of the reactions between nitric acid and saturated hydrocarbons. (5) Kinetics of the carbon monoxide-ozone system. (6) Flame stabilization at surfaces. A brief recapitulation is presented on each of the above.

1759

Princeton U. James Forrestal Research Center, N. J.

DETERMINATION OF DIFFUSION COEFFICIENTS IN SOLIDS BY THE RESIDUAL ACTIVITY METHOD, by R. H. Condit. Feb. 1959 [17]p. incl. diagrs. tables. (Metallurgy rept. no. 19) (AFOSR-TN-59-150) (AF 18(600)967) AD 210984; PB 140812 Unclassified

The determination of diffusion coefficients in solids with radioactive tracers is discussed with special reference to the frequently used, residual activity method. In this method the profile of tracer concentration after diffusion into the solid from a flat, plated surface is determined from measurements of the activity remaining in the solid following removal of successive layers from the surface. The proper procedure for relating the count of activity after each cut to the actual concentration of tracer is presented, necessary correction factors which were computed are given graphically, and their use is illustrated by application to an actual experimental case. (Contractor's abstract)

1760

Princeton U. [James Forrestal Research Center] N. J.

ATOMIC DIFFUSION IN IRON SULFIDE STUDIED AS PART OF A PROGRAM OF RESEARCH ON THE HIGH TEMPERATURE CORROSION OF METALS, by R. H. Condit. [1959] [11]p. incl. diagrs. (AFOSR-TN-59-1180) (AF 18(600)967) Unclassified

Presented at meeting of the Sixth annual ARDC Science and Engineering Symposium, Washington, D. C., Oct. 1-2, 1959.

Some factors controlling atomic diffusion were studied using ferrous sulfide as a medium. Diffusion measurements were carried out with conventional radioactive tracer technique. In ferrous sulfide at about 300°C,

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compositions near that of Fe_7S_8 were observed. Discussion of the obtained results showed that metal diffusion was controlled by crystal structure, the concentration of vacancies in Fe-lattice sites and the mobility of these vacancies as they become reduced by ordering forces at low temperatures.

1761

Princeton U. James Forrestal Research Center, N. J.

THE OXIDATION OF METALS AND ALLOYS. Final rept. Sept. 1, 1953-Dec. 31, 1958 [39]p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-43) (AF 18(600)-967) AD 214525 Unclassified

Contributions of this project are classified under the following topics: (1) The absorption of non-collimated radiation in the experimental measurement of diffusion coefficients by tracer techniques; (2) The plasticity of oxidizers and the effect of pores and cracks on the kinetics of oxidation of metals; (3) The role of defects in oxide and sulfide crystals on conductivity, diffusion, and scale growth; (4) Metal-sulfide equilibria for the PbS-Pb , $\text{WS}_2\text{-W}$, and $\text{Rh}_8\text{S}_7\text{-Rh}$ pairs; (5) The Fe-Ni-O equilibria and the course of the oxidation reaction of iron-nickel alloys; and (6) The variation of self-diffusivity in the Curie point of alpha iron. See Vols. I and II for reports completed under this contract.

1762

Princeton U. James Forrestal Research Center, N. J.

THE ROLE OF SPINEL OXIDES IN THE OXIDATION OF IRON AND ITS ALLOYS, by C. E. Birchenall. [1959] [4]p. incl. refs. (AFOSR-3561) (AF 18(600)-967) Unclassified

Published in *Zeitschr. Elektrochem.*, v. 63: 790-793, 1959.

Alloying elements in iron may decrease the rate of oxidation by lowering the composition range of wüstite or by eliminating it as a stable phase in the presence of the alloy and spinel phases. Additional protection may be obtained if the alloying element lowers the range of defect concentration in the spinel phase or decreases the ion mobilities. A sufficiently great decrease in mobilities of the cations may lead to anion control of the spinel growth rates. A working hypothesis to be used as a guide to diffusion studies in spinels is presented. (Contractor's abstract)

1763

Princeton U. James Forrestal Research Center, N. J.

A REDETERMINATION OF THE LEAD-LEAD SULFIDE

EQUILIBRIUM BETWEEN 585° AND 920°C, by J. R. Stuboles and C. E. Birchenall. [1956] [4]p. incl. diagr. table. (AFOSR-3563) (AF 18(600)967) Unclassified

Also published in *Trans. Metall. Soc. AIME*, v. 215: 535-538, June 1959.

The equilibrium between lead, lead sulfide, and circulating atmospheres of hydrogen and hydrogen sulfide was measured between 585° and 920°C. The equilibrium atmospheres were analyzed by an iodometric method. The data may be represented by a linear free-energy equation, whose enthalpy and entropy terms have associated errors of ± 1 kcal and ± 1 e.u. Reasons are given for accepting the new data in preference to that which already exists. (Contractor's abstract)

1764

Princeton U. James Forrestal Research Center, N. J.

SELF-DIFFUSION IN ALPHA IRON, by C. E. Birchenall and R. J. Borg. Oct. 1959 [18]p. incl. diagrs. refs. (Metallurgy rept. no. 20) (AFOSR-TN-59-1085) (AF 49-(638)533) AD 227069; PB 144006 Unclassified

Also published in *Trans. Metall. Soc. AIME*, v. 218: 980-984, Dec. 1960.

The self-diffusion coefficients for α -iron have been determined between 980°C to 1167°K using Fe^{55} as the tracer. With decreasing temperature the diffusivity was found to decrease more rapidly than predicted by the Arrhenius equation in the region of the Curie temperature. The diffusion coefficients obtained well above the temperature of the magnetic transformation are more precise and differ substantially from all the previously reported values. In the temperature region beginning at least 50°C above T_c the diffusion coefficient is given by $D = 118 (\pm 2) \exp (-67240/RT) \text{ sq cm sec}^{-1}$. This is the 1st known clearcut demonstration that the diffusivities in solids may depend on temperature in a clearly non-exponential fashion over a considerable range of temperature without the known intervention of impurity control of the defect population. The phenomenological characteristics of the results strongly support short range spin ordering as the source of the effect, but the theory so far developed is very crude and of qualitative value only. A short range order treatment of a ternary system - spins up, spins down and spins missing - is required. (Contractor's abstract)

1765

Princeton U. Palmer Physical Lab., N. J.

THE PHYSICAL NUCLEON IN STATIC SOURCE MESON THEORY, by F. Halpern, L. Sartori and others. [1959] [20]p. incl. tables, refs. (Sponsored

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jointly by Air Force Office of Scientific Research under [AF 49(638)304], Atomic Energy Commission, and Office of Naval Research) Unclassified

Published in Ann. Phys., v. 7: 154-173, June 1959.

A wave function for the physical nucleon in static source meson theory was constructed by the method of moments. The wave function includes contributions from states containing as many as 5 mesons, and is shown to be a good approximation to the ground state of the Hamiltonian. Because of the restrictive nature of the static model, the probability that the meson cloud have a particular angular momentum or isotopic spin turns out to be almost independent of the dynamics of the system. Since the matrix elements of the nucleon spin and isotopic spin operators can be expressed in terms of these probabilities, such matrix elements are determined essentially by the kinematics of the meson cloud. This fact renders unreliable any predictions of the static model which depend on matrix elements of the nucleon operators. The consistent failure of the static model to explain satisfactorily the scalar part of the magnetic moment may be ascribed to this cause. The quantities which depend on meson operators are more closely related to the dynamics of the system. The vector part of the magnetic moment is in agreement with experiment, and the electron-neutron interaction turns out much too large; these results differ little from those obtained by the Chew-Low 1-meson approximation. However, the contributions of the many meson states are not negligible, and the mean number of mesons is found to be closer to 2 than to 1. Evaluation of the charge renormalization enables the scattering amplitudes predicted to be tested by the static model against the sum rules of Cini and Fubini. It is found that, for the conventional value of renormalized coupling constant, the sum rules are strongly violated. This result, together with the substantial many meson component of the wave function, casts doubt on the validity of the 1-meson approximation in the static model. (Contractor's abstract)

1766

Princeton U. Palmer Physical Lab., N. Y.

ON THE POSITIVE DEFINITE MASS OF THE BONDI-WEBER-WHEELER TIME-SYMMETRIC GRAVITATIONAL WAVES, by D. R. Brill. [1959] [18]p. incl. table. [AF 49(638)304] Unclassified

Published in Ann. Phys., v. 7: 466-483, Aug. 1959.

The total mass-energy can be given an unambiguous value for any gravitational disturbance which is sufficiently concentrated that its asymptotic behavior is Schwarzschildian in character. It is sufficient to consider such a disturbance on an initial surface to determine the energy, since it is conserved in time. For the case of time- and axial-symmetry the initial value equations reduce to a single equation involving 2 undetermined functions. It was shown here that solutions exist which are everywhere regular and asymptotically

flat. Such solutions are to be regarded as "snapshots" of pure gravitational waves. It was shown without approximation that the total mass-energy is positive definite for pure gravitational waves, as well as for combined electromagnetic and gravitational waves, which are time and axially symmetric. The mass-energy of these waves exhibits a complete spectrum from zero to infinity. Using the method of solution described 1 can obtain "snapshots" of gravitational waves at the moment of time-symmetry with any desired value of the mass-energy, by varying the parameter ω^2 between 0 and its critical value. At the critical value the solution represents a universe which is closed by its own content of gravitational energy. Computations of exact solutions representing such waves and universes are being programmed on an electronic computer. (Contractor's abstract)

1767

Princeton U. Palmer Physical Lab., N. J.

INTERFERENCE EFFECTS IN NEUTRAL K-PARTICLE DECAY, by S. B. Treiman and S. Weinberg. [1959] [2]p. incl. tables. [AF 49(638)304] Unclassified

Published in Phys. Rev., v. 116: 239-240, Oct. 1, 1959.

An analysis is made of interference effects between the K_1^0 and K_2^0 components of a neutral K beam for decay in the channel $\pi^+ + \pi^- + \pi^0$. The effects discussed, though expected to be small, may just be detectable. If so, they would serve as a test of the proposed $|\Delta T| = 1/2$ rule. (Contractor's abstract)

1768

Princeton U. Palmer Physical Lab., N. J.

ELECTROMAGNETIC CORRECTIONS TO ISOTOPIC SPIN CONSERVATION, by S. Weinberg and S. B. Treiman. [1959] [4]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)304] and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 116: 465-468, Oct. 15, 1959.

If electromagnetic interactions are wholly responsible for all departures from isotopic spin invariance, then the strict conservation law $\Delta T = 0$ may be replaced, to order e^2 , by the rule $|\Delta T| < 2$. Consequences of this weaker restriction are discussed for elementary particle masses, scattering processes, and weak-interaction decay processes. The apparent absence in nature of particles with isotopic spins greater than one makes it difficult to find very practical experimental tests of this rule. (Contractor's abstract)

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Princeton U. Palmer Physical Lab., N. J.

ACTIVE GRAVITATIONAL MASS, by C. W. Misner and P. Putnam. [1959] [2]p. incl. table. [AF 49(638)-304] Unclassified

Published in Phys. Rev., v. 116: 1045-1046, Nov. 15, 1959.

Tolman states that "... disordered radiation in the interior of a fluid sphere contributes roughly speaking twice as much to the gravitational field of the sphere as the same amount of energy in the form of matter." The gravitational pull exerted by a system on a distant test particle might therefore at first sight be expected to increase if within the system a pair of oppositely charged electrons annihilate to produce radiation. This apparent paradox is analyzed here in the case where gravitational effects internal to the system are unimportant. It is shown that tensions in the wall of the container compensate the effect mentioned by Tolman so that the net gravitational pull exerted by the system does not change. (Contractor's abstract)

1770

Princeton U. Palmer Physical Lab., N. J.

EXACT THREE-VARIABLE SOLUTIONS OF THE FIELD EQUATIONS OF GENERAL RELATIVITY, by B. K. Harrison. [1959] [12]p. incl. diagrs. refs. [AF 49(638)304] Unclassified

Published in Phys. Rev., v. 116: 1285-1296, Dec. 1, 1959.

In order to trace out with more understanding the consequences of general relativity it is advantageous to have exact solutions of Einstein's field equations which show more detail than the familiar solutions with their high symmetry. In the present investigation, based on the method of separation of variables, all solutions of the field equations for empty space have been found which (1) have the "linked pair" form $g_{ij} = \pm \delta_{ij} A_i^2$ (x^0, x^1) B_j^2 (x^0, x^3), and which (2) are nondegenerate-so far as could be determined-in the sense that all the g_{ij} cannot be reduced to functions of only 2 variables. Other solutions have been obtained from the solutions of the above form by interchange of variables. Explicit expressions are given for all 20 nondegenerate solutions, all apparently new. Of degenerate solutions, 10 are presented, not all of them new. All 30 solutions are examined with respect to possible physical and geometrical interpretations.

1771

Princeton U. Palmer Physical Lab., N. J.

A CONTRACTION RULE FOR COMPOSITE PARTICLES, by R. Blankenbecler. [1959] [9]p. incl. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)304] and National Science Foundation) Unclassified

Published in Nuclear Phys., v. 14: 97-105, Dec. 1959.

A contraction rule for an arbitrary composite particle is derived, based on results due to Nishijima, and Klein and Zemach. This relation between this contraction rule and the analogous problem in potential scattering is demonstrated by an explicit reduction to the nonrelativistic limit. Applications of these rules are briefly discussed. (Contractor's abstract)

1772

Puerto Rico U. Dept. of Electrical Engineering, Mayaguez.

CHARACTERISTIC OF A PECULIAR BACK-SCATTER ECHO OBSERVED AT A FREQUENCY OF 21.6 MC. P.S., by B. Dueno. [1959] 24p. incl. illus. diagrs. tables. (Research rept. no. 1) (AFOSR-TN-59-40) (AF 49(638)172) AD 209212; PB 139212 Unclassified

Inspection of records of a backscatter experiment performed at Puerto Rico U. at Mayaguez has revealed a very interesting echo which as yet, has not been observed at back-scatter stations located on higher latitude sites. This echo takes the form of a narrow thin line reflection extending in all directions with its slant range practically independent of its azimuthal bearing. The bottom edge of the line is believed to be due to a focusing effect of the minimal time delay type proposed by A. M. Peterson in 1951 while the upper edge is due to a focusing effect between the skip distance rays and rays at greater angles of incidence having the same time delays as the skip distance rays. At the frequency of operation, 21.6 mc it is observed by itself at times when the attenuation of the radio waves is at its highest. The range assumes values between 1000 and 2000 km depending on time of the day and season. The lowest value of range, 1000 km, occurs during the winter months. Since, in addition, the thin line echo disappears during the summer months, when it is observed only sporadically, the echo is assumed to be an F-2 layer echo. There are reasons to believe that for a given parabolic distribution, that with the greatest half thickness should produce the strongest focusing effect. An opportunity to test the validity of this statement is afforded by the sporadic appearances of the thin line during the summer. An estimation of the half thickness of the F-2 layer deduced from ionograms for two consecutive days of appearance and nonappearance of the thin line seems to confirm the aforementioned statement.

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1773

Puerto Rico U. Dept. of Electrical Engineering, Mayaguez.

PECULIARITIES AND SEASONAL VARIATIONS OF T. E. BACKSCATTER ECHOES OBSERVED AT MAYAGUEZ, PUERTO RICO, by B. Dueño. [1959] [14]p. incl. diagrs. (Research rept. no. 2) (AFOSR-TN-59-889) (AF 49(633)172) AD 225968; PB 144658
Unclassified

As a result of a backscatter experiment on 21.6 mcs and 40.68 mcs it has been observed that long range transequatorial echoes (T. E.), which are most prevalent during the equinoxial periods, also exhibit a minimum of T. E. activity during the solstitial periods June - July and December - January. The minimum during December and January can be ascribed to the small horizontal gradient prevailing at the time. During June - July the horizontal gradient is not as small as during December - January. This coincides with the observation that T. E. activity is not as low in June - July as it is in December - January. Due to the combined action of the equatorial bulge and sizable horizontal gradients in the neighborhood of the geomagnetic equator, radio waves of sufficiently high frequencies will be launched into the ionosphere in directions along the maximum of electron density of the elevated layer. To produce focussing by a bundle of rays, a shallow distribution of electron density in the layer is necessary. This is in agreement with the postulated decrease in electron density as the geomagnetic equator is approached. (Contractor's abstract)

1774

Puget Sound Coll. [Tacoma, Wash.].

THE PREPARATION, STRUCTURE AND PROPERTIES OF CERTAIN METHYLENE PEROXIDES, by R. D. Sprenger. Final rept. Sept. 1952-Sept. 1959. Nov. 1959, 4p. incl. diagrs. (AFOSR-TR-59-171) (AF 18-(600)544)
Unclassified

A summary of results reached under this contract are presented. This research has been concerned with the formation, structure and properties of isochroman peroxide of which 2 forms have been obtained by the air oxidation of isochroman. Existence as dimorphic forms seems most likely, but efforts to interconvert the 2 forms have been unsuccessful. The studies of peroxidation of these 2 forms is reported on also, and they indicate that small amounts of impurities are present which influence the peroxidation rate. A mechanism for peroxidation is suggested. It is pointed out that the lower melting form (m. p. 128.9-130.4°C) and the higher melting form (m. p. 152.9-154.4°C) have been found to give identical ultra violet and infrared spectra. Efforts to differentiate them have been unsuccessful also.

1775

Purdue Research Foundation, Lafayette, Ind.

EXTENSION PROBLEM FOR QUASI ADDITIVE SET FUNCTIONS AND RADON-NIKODYM DERIVATIVES, by L. Cesari. Apr. 1959, 44p. incl. refs. (Technical note no. 17) (AFOSR-TN-59-477) (AF 18(600)1484) AD 215720; PB 142230
Unclassified

A discussion is presented of the problem of extension of quasi additive set functions $\Phi, \Phi_r, |\Phi|, |\Phi_r|, \Phi_+, \Phi_-$ into measures $\nu, \nu_r, \mu, \mu_r, \mu_+, \mu_-$ in A , and consequent representation theorem for the integral I .

1776

Purdue Research Foundation, Lafayette, Ind.

QUASI ADDITIVE SET FUNCTIONS AND THE CONCEPT OF INTEGRAL OVER A VARIETY, by L. Cesari. Apr. 1959, 32p. (Technical note no. 16) (AFOSR-TN-59-47d) (AF 18(600)1484) AD 264037; PB 142231
Unclassified

A topological treatment of quasi additive set functions is presented and the application of surface area theory is made through the use of the calculus of variations by various authors. Theorems, proofs, and examples of several integrals are given. (ASTIA abstract)

1777

Purdue Research Foundation, Lafayette, Ind.

ANALYTICAL THEORY OF CONTINUOUS TRANSFORMATIONS I, by T. Nishitani. Aug. 1959 [70]p. incl. refs. (Technical note no. 20) (AFOSR-TN-59-496) (AF 18(600)1484) AD 263800; PB 143179
Unclassified

An analysis of the theory of continuous transformations is made. It concerns the analog of the Geöcze area of mappings from specific subsets of Euclidean k -space, E_k , and Euclidean N -space, E_N . By use of combinatorial topology and algebraic topology the notion of polyhedral regions is defined. Theorems and proofs of constructions of certain polyhedral regions are presented. (ASTIA abstract)

1778

Purdue Research Foundation, Lafayette, Ind.

ANALYTIC THEORY OF CONTINUOUS TRANSFORMATIONS II, by T. Nishitani. Aug. 1959 [131]p. incl. refs. (Technical note no. 21) (AFOSR-TN-59-496a) (AF 18(600)1484) AD 263801; PB 143180
Unclassified

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The present work is a continuation of the extension of the theory of the Geöcze "k-area" which was started in item no. 1777, Vol. III.

1779

Purdue Research Foundation, Lafayette, Ind.

ANALYTIC THEORY OF CONTINUOUS TRANSFORMATIONS III, by T. Nishiura. Aug. 1959 [17]p. incl. refs. (Technical note no. 22) (AFOSR-TN-59-496b) (AF 18(600)1484) AD 263803; PB 144071

Unclassified

This analysis deals with the generalized length of a contour and the Cavalieri inequality for continuous mappings defined on admissible sets in the plane. (Contractor's abstract)

1780

Purdue Research Foundation, Lafayette, Ind.

A CHARACTERIZATION OF MULTICOHERENT PEANO SPACES, by A. Lauria and C. J. Neugebauer. Nov. 1959, 14p. incl. refs. (Technical note no. 19) (AFOSR-TN-59-801) (AF 18(600)1484) PB 144753

Unclassified

Let P be a Peano Space, and denote by τ the collection of all continuous mappings $T: P \rightarrow [0, 1]$. For each $T \in \tau$ let $1m = T$, $m: P \rightarrow M_T$, $1: M_T \rightarrow [0, 1]$ be a

monotone-light factorization of T . In this paper the above theorem is generalized to Peano spaces of finite degree of multicoherence $r(P)$. A number $a(P)$ will be associated with P which measures roughly the maximum number of distinct arcs with self-intersections joining any two points in any M_T . The theorem states that $r(P) = n$ if and only if $a(P) = 2^n$.

1781

Purdue Research Foundation, Lafayette, Ind.

RETRACTIONS ONTO DENDRITES, by A. Lauria and C. J. Neugebauer. Nov. 1959, 13p. (Technical note no. 18) (AFOSR-TN-59-802) (AF 18(600)1484) PB 144214

Unclassified

Let X be a normal Hausdorff space and α be any simple arc contained in X . Then α is a retract of X , that is, there exists a continuous function F taking X onto α such that the restriction of F to α is the identity mapping. This is a simple consequence of the Tietze Extension Theorem. If X is a unicoherent Peano space then the retraction F can be chosen to be a monotone mapping. In this paper both of these results are generalized and the following is obtained: Theorem. If X is any normal Hausdorff space and Δ is a dendrite in X , then Δ is a retract of X . Corollary. If X is a unicoherent Peano

space and Δ is a dendrite in X , then Δ is a monotone retract of X . The theorem and corollary are proved, but it is shown that the corollary is no longer true if X is not locally connected or unicoherent.

1782

Purdue [Research Foundation] Lafayette, Ind.

RECENT RESULTS IN SURFACE AREA THEORY, by L. Cesari. [1959] [20]p. incl. diagrs. [AF 18(600)1484]

Unclassified

Published in Amer. Math. Monthly, v. 66: 173-192, Mar. 1959.

An approach to surfaces is discussed which entails a much deeper connection with topology and measure theory than with curves. The concept of surfaces is reviewed followed by a discussion of Lebesgue area and its lower semicontinuity property. A discussion is also presented on Peano and Geöcze areas and the relation between area and integral. The Weierstrass-type integral and fine-cyclic elements are also discussed.

1783

[Purdue Research Foundation, Lafayette, Ind.]

MEASURES INDUCED ON A σ -ALGEBRA BY A SURFACE, by L. H. Turner. [1959] [7]p. (AF 18(600)1484)

Unclassified

Published in Duke Math. Jour., v. 26: 501-509, Sept. 1959.

Let (T, A) be a continuous a.c.Bv mapping from an admissible set A into E_3 and $T_r = P_r \circ T$ where P_r is a perpendicular projection on the r th coordinate plane for $r = 1, 2, 3$. For A compact, regular measures ϕ_r , ϕ_r^+ , ϕ_r^- , $r = 1, 2, 3$, on the middle space which agrees for open sets with area and the corresponding variations of the plane transformations T_r , respectively. The restriction that A be compact is removed. It is also shown that ϕ_r^+ and ϕ_r^- are mutually singular. (Math. Rev. abstract)

1784

Purdue Research Foundation, Lafayette, Ind.

LEBESGUE AREA OF MAPS FROM HAUSDORFF SPACES, by R. F. Williams. [1959] [14]p. incl. diagrs. [AF 18(600)1484]

Unclassified

Published in Acta Math., v. 102: 33-46, 1959.

Let X be a compact m -dimensional Hausdorff space

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and f a map from X into Euclidean n -space. Using nerves of open coverings of X 2 functions L_m^p and L_m^* are introduced and compared with the Lebesgue m -dimensional area L_m of the surface represented by f . From the definitions it follows that $L_m^p \leq L_m^*$. Moreover, $L_m^* \leq L_m$ if X is finitely triangular. If X is a compact 2-manifold it is shown that $L_2^* = L_2$. For light maps it is proved that L_m^* does not exceed the lower Riemann integral of the crude multiplicity M_f . An example is given of a light map f from a finitely triangular space X onto the unit square for which L_2 exceeds both L_2^* and the Riemann integral of M_f . (Math. Rev. abstract)

1785

Purdue Research Foundation, Lafayette, Ind.

ON DIFFERENCES OF UNITARILY EQUIVALENT SELF-ADJOINT OPERATORS, by C. R. Putnam. May 1959, 9p. (Technical note no. 9) (AFOSR-TN-59-413) (AF 18(603)139) AD 214530 Unclassified

Suppose that A and B are bounded self-adjoint operators satisfying $H = A - B \geq 0$. In case B is unitarily equivalent to A , that is if $B = U^*AU$ and if $H \geq 0$, $\neq 0$, then the spectral resolution of U must have an absolutely continuous component. In particular, the spectrum of U has a positive measure. If $H = DD^* - D^*D$ and if D is non-singular with a polar factorization $D = PU$ ($P > 0$, U unitary) then U must have a spectrum with a positive measure. It is shown that P must have at least 2 points in its cluster spectrum. (Contractor's abstract)

1786

Purdue Research Foundation, Lafayette, Ind.

A NOTE ON NON-NEGATIVE MATRICES, by C. R. Putnam. Mar. 1960, 6p. (Technical note no. 10) (AFOSR-TN-59-692) (AF 18(603)139) AD 233512; PB 146377 Unclassified

Also published in Canad. Jour. Math., v. 13: 59-62, 1961.

Results on non-negative matrices previously obtained (PRF.02:008, Vol. II) are extended. (Contractor's abstract)

1787

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE THERMODYNAMIC PROPERTIES OF TECHNETIUM AND RHENIUM COMPOUNDS. VII. HEATS OF

FORMATION OF RHENIUM TRICHLORIDE AND RHENIUM TRIBROMIDE. FREE ENERGIES AND ENTROPIES, by J. P. King and J. W. Cobble. Oct. 1959, 10p. incl. tables, refs. (AFOSR-TN-59-968) (AF 18(600)1525) AD 227927; PB 145532 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2111-2113, May 5, 1960.

The heats of oxidation of $\text{ReCl}_3(c)$ and $\text{ReBr}_3(c)$ by basic hypochlorite have been determined. From these data the heats of formation at 25°C have been calculated to be: $\text{ReCl}_3(c)$, $-63.1 \pm 0.8 \text{ kcal mol}^{-1}$ and $\text{ReBr}_3(c)$, $-39.9 \pm 0.09 \text{ kcal mol}^{-1}$. Free energy and entropy estimates are also given. (Contractor's abstract)

1788

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE HEAT OF FORMATION OF THE HYPOCHLORITE ION, by J. E. McDonald, J. P. King, and J. W. Cobble. [1959] [2]p. incl. table, refs. (AFOSR-TN-59-1042) (AF 18(600)1525) Unclassified

Also published in Jour. Phys. Chem., v. 64: 1345-1346, Oct. 28, 1960.

The heat of formation of the hypochlorite ion has been redetermined calorimetrically at 25° by measuring the heat of hydrolysis of chlorine in basic solutions. The value obtained was $\Delta H^\circ = -26.2 \pm 0.1 \text{ kcal/mol}$ (item no. 1790, Vol. III). Using this value in conjunction with that for the free energy of formation, $\Delta F^\circ = -8.858 \text{ kcal/mol}$, the entropy is calculated to be 8.6 ± 0.3 entropy units. (Contractor's abstract)

1789

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE THERMOCHEMISTRY OF RHENIUM COMPOUNDS, by J. P. King. Oct. 1959, 96p. incl. diagrs. tables, refs. (AFOSR-TN-59-1164) (AF 18(600)1525) AD 228839; PB 144741 Unclassified

The potential and temperature coefficient of the $\text{ReO}_3/\text{ReO}_4^-$ couple at 25°C obtained from cell measurements was found to be $-0.768 \pm 0.005 \text{ v}$ and $0.00121 \pm 0.00011 \text{ v deg}^{-1}$, respectively. The thermodynamic functions of rhenium trioxide at 25°C were calculated to be $-146.9 \pm 0.8 \text{ kcal mol}^{-1}$, $-128.1 \pm 0.8 \text{ kcal mol}^{-1}$ and $19.3 \pm 2.5 \text{ cal mol}^{-1} \text{ deg}^{-1}$ for the heat of formation, the free energy of formation and the entropy, respectively. The heats of oxidation of $\text{ReCl}_3(c)$ and $\text{ReBr}_3(c)$ by basic hypochlorite were determined by solution calorimetry. From these data the heats of formation at 25°C were

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calculated to be: $\text{ReCl}_3(\text{c})$, $-63.6 \pm 0.8 \text{ kcal mol}^{-1}$ and $\text{ReBr}_3(\text{c})$, $-39.9 \pm 0.8 \text{ kcal mol}^{-1}$. The potential of Re/Re^- couple obtained from both acidic and basic cells was found to be $0.136 \pm 0.02 \text{ v}$ at 0°C . The heat of formation of aqueous rhenide ion obtained from calorimetric measurements at 25°C is $11.4 \pm 3 \text{ kcal mol}^{-1}$. From entropy considerations, the simple halide-like structure of rhenide ion was shown to be very improbable. A new calorimetric oxidant, basic hypochlorite, was investigated and its application for the calorimetric measurements of certain halides of 2nd and 3rd row transition elements was proposed. The heat of formation of the hypochlorite ion at 25°C is determined calorimetrically to be $-25.90 \pm 0.05 \text{ kcal mol}^{-1}$ by measuring the heat of hydrolysis of aqueous chlorine in basic solutions. (Contractor's abstract)

1790

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE HEAT OF FORMATION OF THE HYPOCHLORITE ION, by J. P. King and J. W. Cobble. [1959] [4]p. incl. table, refs. (Bound with its AFOSR-TN-59-1164; AD 228839) (AF 18(600)1525) Unclassified

The heat of formation of the hypochlorite ion at 25°C has been redetermined calorimetrically by measuring the heat of hydrolysis of aqueous chlorine in basic solutions. The value obtained was $\Delta H^\circ = -25.90 \pm 0.05 \text{ kcal mol}^{-1}$. (Contractor's abstract)

1791

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE STRUCTURE AND ENTROPY OF AQUEOUS RHENIDE ION, by J. P. King and J. W. Cobble. [1959] [12]p. incl. tables, refs. (Bound with its AFOSR-TN-59-1164; AD 228839) (AF 18(600)1525) Unclassified

The potential of Re/Re^- couple was measured in both acidic and basic solutions at 0°C and the standard electrode potentials of the rhenide electrode was found to be $0.136 \pm 0.020 \text{ v}$ at 0°C and $0.101 \pm 0.020 \text{ v}$ at 25°C ; the free energy of formation of aqueous rhenide ion was calculated from latter value to be $2.3 \pm 0.5 \text{ kcal mol}^{-1}$ at 25°C . The heat of formation of aqueous rhenide ion was calorimetrically determined to be $+11.4 \pm 3 \text{ kcal mol}^{-1}$. The entropy of the species at 25°C is 55 ± 10 entropy units. (Contractor's abstract)

1792

Purdue U. Dept. of Chemistry, Lafayette, Ind.

A MODIFIED URRY TOEPLER PUMP, by F. Vratny

and B. Graves. Apr. 22, 1958, 4p. incl. diagr. (AFOSR-TN-59-302) (AF 18(603)45) AD 213086; PB 140536
Unclassified

Also published in Rev. Sci. Instr., v. 30: 597-598, July 1959.

At moderate pressure (0-5 cm Hg), splashing occurred in the downstroke cycle of an Urry Toepler pump which was being employed for the pumping and circulating of gas. At high pressure, violent splashing destroyed the pump. Entrapped gas in the upper portion of the pump was troublesome in the pumping to very low pressures or in the quantitative transfer of a given gas. The modification of the Urry Toepler pump to eliminate these deficiencies is discussed. (ASTIA abstract)

1793

Purdue U. Dept. of Chemistry, Lafayette, Ind.

REFLECTANCE SPECTRA OF PRASEODYMIUM OXIDES IN THE RANGE Pr_2O_3 TO Pr_6O_{11} , by F. Vratny, M. Tsai, and J. M. Honig. Mar. 1958, 10p. incl. diagrs. r.l.s. (AFOSR-TN-59-404) (AF 18(603)45) AD 214524; PB 140805
Unclassified

Also published in Jour. Inorg. and Nuclear Chem., v. 16: 263-267, Feb. 1961.

The spectra of praseodymium oxides (PrO_x) has been studied in the composition range $1.5 < X < 1.83$ from 200 to 2000 μ . An ultraviolet cut-off was observed at about 320 μ , exciton interaction was observed in the spectral range of 400-650 μ , and a band observed in the near infrared which begins at about 900 μ . The spectra are discussed in terms of known changes in the crystalline structure of the material. (Contractor's abstract)

1794

Purdue U. Dept. of Chemistry, Lafayette, Ind.

A SYSTEM FOR THE ANALYSIS OF NITRATES AND OXIDES OF NITROGEN, by F. Vratny. May 1959 [11]p. incl. diagrs. tables. (AFOSR-TN-59-602) (AF 18(603)-45) AD 217175; PB 142733
Unclassified

Also published in Anal. Chim. Acta, v. 21: 579-583, Dec. 1959.

A system was constructed for determining absolute amounts of NO_2 , N_2O_3 , NO , and of either N_2O or a mixture of N_2 and O_2 simultaneously present in the gas phase. The system consists of a reaction chamber, a Ni-NiO tube, a pumping and manometering section, and 2 purification sections. The entire system is evacuated to a pressure of 10^{-6} mm of Hg; this eliminates the possibility of analyzing compounds that are volatile at room

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temperature. The decomposition products pass a cold trap which separates the $\text{NO}_2\text{-N}_2\text{O}_3$ components from the more volatile NO and the N_2O or $\text{N}_2\text{-O}_2$ mixture. An Ni-asbestos mixture is heated to 800°C to remove the O components from the nitrogeous gas phase. NiO is reduced by H to yield water vapor; the excess H is metered. The mol quantities of N_2 and H_2 are computed, and the mol quantity of O is deduced. The procedure is repeated for nitrogen oxides that are condensed in the trap. The decompositions of $\text{Ba}(\text{NO}_3)_2$, $\text{Pb}(\text{NO}_3)_2$, and NH_4NO_3 were studied. Results indicated that the analytical procedure yields correct data under carefully controlled conditions and may be applied with confidence.

1795

Purdue U. Dept. of Chemistry, Lafayette, Ind.

GROWTH AND CRYSTAL STRUCTURE OF SINGLE CRYSTALS OF $\text{Pr}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, by J. W. Richardson,

Q. W. Choi and others. July 1959, 4p. incl. table. (AFOSR-TN-59-638) (AF 18(603)45) AD 218018

Unclassified

Single crystals of $\text{Pr}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$ were grown by dissolving Pr_6O_{11} in HCl solution and evaporating the solution almost to dryness. The resulting chloride was treated 3 times with HNO_3 and evaporated almost to dryness in a steam bath. The residue was placed in a desiccator together with a 15% NaOH solution in another beaker. The $\text{Pr}(\text{NO}_3)_3$ dissolved in H_2O withdrawn from the NaOH solution. A 40 to 45% aqueous NaOH solution was placed in the desiccator. The higher vapor pressure of the $\text{Pr}(\text{NO}_3)_3$ solution caused a slow transfer of H_2O to the NaOH reservoir. This resulted in the growth of a single crystal of $\text{Pr}(\text{NO}_3)_3 \cdot 6\text{H}_2\text{O}$, with dimensions of $2 \times 1.5 \times 0.5$ cm. The crystal exhibited a marked spiral dislocation pattern on the top surface. X-ray diffraction studies were made on the crystal using a Weissenberg camera and Ni-filtered CuK_α radiation. The crystal was monoclinic and had the following cell constants: $a_0 = 8.84 \pm 0.05$ A, $b_0 = 11.75 \pm 0.05$ A, $c_0 = 6.78 \pm 0.05$ A, and $\gamma = 112 \pm 3^\circ$. The calculated density for 2 formula units per unit cell was 2.42 g/cc compared to 2.48 g/cc observed by displacement of ethylacetate. Indexing the Weissenberg data revealed that all hko reflections were present. The lattice constants were computed assuming that the lattice was primitive and that no glide planes occurred.

1796

Purdue U. Dept. of Chemistry, Lafayette, Ind.

THE THERMAL DECOMPOSITION OF PRASEODYMIUM NITRATE, by F. Vratny and J. M. Honig. Nov. 1959 [29]p. incl. diagrs. refs. (AFOSR-TN-59-1153) (AF 18(603)45) AD 228959; PB 144944

Unclassified

Also published in Trans. Faraday Soc., v. 56: 1051-1058, July 1960.

The thermal decomposition of $\text{Pr}(\text{NO}_3)_3$ has been measured in the temperature range $265 < T < 465^\circ\text{C}$. In conjunction with infrared spectra of the solid decomposition products it is postulated that the reaction proceeds via an intermediate nitrite structure. The composition of the final nonstoichiometric oxide varied with the temperature at which the reaction was allowed to proceed. Various characteristic features of this decomposition reaction are discussed. (Contractor's abstract)

1797

[Purdue U. Dept. of Chemistry, Lafayette, Ind.]

SYMPOSIUM ON THE CHEMISTRY OF LESS FAMILIAR ELEMENTS, San Francisco, Calif., Apr. 14-16, 1959, by J. W. Cobble. Final rept. Aug. 1959, 44p. (AFOSR-TR-59-101) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)233 and American Chemical Society) AD 226190; PB 143887

Unclassified

Presented at meeting of the Inorg. Chem. Div. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Also published in 133rd meeting of the Amer. Chem. Soc., Abstracts of Papers, 1958, p. 10-L-12-L; 16-L-18-L; 20-L-24-L; 29-L-31-L.

On April 14 - 16, 1959, the Air Force Office of Scientific Research and the American Chemical Society Division of Inorganic Chemistry held a joint symposium at the National American Chemical Society Meeting in San Francisco, California. Twenty-nine papers, including those by eight foreign speakers from five countries were presented. Because of the preliminary nature of many of the papers, the authors and co-chairmen agreed not to attempt to publish the symposium as a separate collection. This final report includes, therefore, a program, list of speakers, list of foreign participants, and copies of the abstracts of the papers.

1798

Purdue U. [Dept. of Chemistry] Lafayette, Ind.

AN APPLICATION OF THE HAMMETT EQUATION TO SUBSTITUTED FERROCENE CARBOXYLIC ACIDS, by

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R. A. Benkeser and L. W. Hall, Jr. [1959] 7p. Incl. diagrs. table, refs. (AFOSR-TN-59-450) (AF 49(638)-297) AD 225119; PB 140775 Unclassified

A series of substituted ferrocene carboxylic acids were prepared and their ionization constants measured. Rather poor correlation was noted when the ionization constants of the ferrocene acids were plotted against Hammett sigma values. On the other hand, excellent correlation with Taft's σ^* was obtained. These results would indicate that the electrical effects operative between the rings of ferrocene are essentially inductive in nature. Further tests of this hypothesis are presently underway. (Contractor's abstract)

1769

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

[TWO DIMENSIONAL PROBLEMS OF THE CALCULUS OF VARIATIONS], by W. H. Fleming. Final rept. [1959] 2p. (AFOSR-TR-59-113) (AF 49(638)18) Unclassified

A review of the research conducted under this contract is presented. One paper (PUR.11:003, Vol. II) discusses the most general existence theorem for double integral variational problems in parametric form known to date. It uses the method of generalized surfaces which applies to both regular and non-regular problems. Two others (PRF.01:004, Vol. I and PUR.11:002, Vol. II) deal with surfaces in the more general sense. These 3 papers thus, deal with a phase of surface area theory which is drawing to a close, namely, the study of 2-dimensional surfaces of finite genus situated in ordinary finite dimensional space. The other paper submitted under this contract, (PUR.11:001, Vol. II) is concerned with generalized surfaces of arbitrary finite dimension k situated in $(k+1)$ -dimensional space. This paper appears to be one of the first in a new phase of surface area theory which deals with surfaces of arbitrary dimension k , and which seems to offer hope of general existence theorems for multiple integral problems in calculus of variations of any dimensions.

1800

Purdue U. Dept. of Mathematics, Lafayette, Ind.

A SPACE OF MULTIPLIERS OF TYPE $L^p(-\infty, \infty)$, by G. L. Krabbe. Nov. 20, 1959, 13p. Incl. refs. (AFOSR-TN-59-170) (AF 49(638)505) AD 232457; PB 146009 Unclassified

Also published in Pacific Jour. Math., v. 9: 729-737, 1959.

Let $V(G)$ denote the set of all functions having finite variation on G . Set $G = (-\infty, \infty) = \hat{G}$, and let $V_\infty(G)$ be the Banach space of all functions in $V(G)$ which vanish at infinity. If $f \in V_\infty(G)$, then there exists a bounded

linear operator (t, f) on $L^p(\hat{G})$ such that (Fourier transform of $(t, f)x$) = $f \cdot$ (Fourier transform of x) for all x in $L^p(\hat{G})$. Suppose $1 < p < \infty$. When $f \in L^1(G) \cap V(G) \subset V_\infty(G)$, then (t, f) is a singular integral operator. For all x in $L^p(\hat{G})$, $(t, f)x$ is found to have the form

$$[(t, f)x]_\lambda = \frac{1}{2\pi i} \int_{-\infty}^{\infty} x(\Theta) \frac{F(\Theta - \lambda)}{\Theta - \lambda} d\Theta, (\lambda \in \hat{G}), \text{ where}$$

the integral is taken in the Cauchy principal value sense.

A set $\Delta(L^p(\hat{G}))$ which contains all factor functions for Fourier transforms of type (L_p, L_p) is defined. A number N_p is found such that if $f \in V_\infty(G)$, then $f \in \Delta(L^p(\hat{G}))$ and $\|(t, f)\| < N_p \|f\|_V$, where $\|f\|_V$ denotes the total variation on G of the function f . Let F_* be the mapping $[x \rightarrow x * F]$, where $x * F$ is the convolution of the functions x and F . Let (Yf) denote the Fourier transform of the function f . If $f \in L^1(G) \cap V(G)$, then the transformation $(YF)_*$ is a densely defined bounded operator, and (t, f) is its continuous linear extension to the whole space $L^p(\hat{G})$. (Contractor's abstract)

1801

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH SPACE $L^p(-\infty, \infty)$. PART I. BOUNDED OPERATORS, by G. L. Krabbe. Nov. 20, 1959, 4p. [Technical note no. 2] (AFOSR-TN-59-579) (AF 49(638)505) AD 232458; PB 146006 Unclassified

Also published in Bull. Amer. Math. Soc., v. 65: 270-272, July 1959.

Let B denote the Boolean ring generated by the semi-closed intervals of the plane. Denote by E_p the algebra of all linear bounded transformations of $L^p(-\infty, \infty)$ into itself. Suppose that $p = 2$, and let A_p be an involutive Abelian subalgebra of E_p . If A_p is also a Banach space and if $T_p \in A_p$, then the family of all homomorphic mappings of the ring B into the algebra E_p contains a member of E_p^T such that $T_p = \int \lambda, E_p^T(d\lambda)$. Suppose that $1 < p < \infty$. Let D be the class of all bounded functions whose real and imaginary parts are piecewise monotone. An isomorphism $f \sim \Lambda(f)_p$ whose domain includes D and whose range $(t)_p$ is a normed involutive abelian subalgebra of E is defined. The main theorem shows that a member T_p of $(t)_p$ has the family of homomorphic mapping property whenever $T_p = \Lambda(f)_p$ for some f in D . The relation (T_p) involves a Stieltjes integral defined in the strong operator-topology whenever $p \geq 2$. (Contractor's abstract)

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1802

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH SPACE L^p
($-\infty, \infty$). Part I, by G. L. Krabbe. Nov. 20, 1959, 21p.
incl. refs. [Technical note no. 3] (AFOSR-TN-59-1115)
(AF 49(638)505) AD 232459; PB 146385 Unclassified

Also published in *Canad. Jour. Math.*, v. 13: 505-518,
1961.

Let BR^2 be the Boolean algebra of all finite unions of sub-cells of the plane. Denote by E_p the algebra of all linear bounded transformations of $L^p(-\infty, \infty)$ into itself. Suppose that $p = 2$, and let R_p be an involutive Abelian sub-algebra of E_p . If R_p is also a Banach space and if $T_p \in R_p$, then the family of all homomorphic mappings of BR^2 into the algebra R_p contains a member E_p^T such that $T_p = \int \lambda \cdot E_p^T(d\lambda)$. Suppose that $1 < p < \infty$. Let D be the class of all bounded functions whose real and imaginary parts are piecewise monotone. An isomorphism $f \rightarrow [\lambda f]_p$ whose domain includes D and whose range $(t)_p$ is a normed involutive abelian sub-algebra of E_p is obtained. A theorem shows that a member T_p of $(t)_p$ has the homomorphic mapping property whenever $T_p = [\lambda f]_p$ for some f in D . The relation T_p involves a Stieltjes integral defined in the strong operator-topology whenever $p > 2$. The set-function E_p^T need not be countably additive. The values of E_p^T are self-adjoint idempotent members of $(t)_p$. (Contractor's abstract)

1803

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH SPACE L^p
($-\infty, \infty$). PART II, UNBOUNDED TRANSFORMATIONS,
by G. L. Krabbe. Nov. 20, 1959, 7p. [Technical note
no. 4] (AFOSR-TN-59-1116) (AF 49(638)505)
AD 232460; PB 146384 Unclassified

Also published in *Bull. Amer. Math. Soc.*, v. 66: 86-90,
Mar. 1960.

Suppose $1 < p < \infty$. The transformation D_p is defined by $D_p x =$ derivative of x for all functions x in the set $D(D_p)$ of all locally absolutely continuous members of $L^p = L^p(-\infty, \infty)$ whose derivative belongs to L^p . The following result is prototypic: $(i/2\pi)D_p$ is a transformation (denoted P_p) that satisfies the spectral theorem. Let L_p denote the norm-topology of L^p when $p > 2$. For

$p < 2$, L_p denotes the weak topology of L^p . Suppose that E is a spectral resolution in L^p , and let f be a function on $(-\infty, \infty)$. If T is a transformation of L^p with domain $D(T)$, then the relation $T \subset \int f(\lambda) \cdot E(d\lambda)$ means that, for all functions x in $D(T)$, the Riemann-Stieltjes integral $\int_{-\infty}^{\infty} f(\lambda) \cdot E(d\lambda)x$ converges to Tx in the topology L_p . Let O_p be the class of all linear transformations Q of L^p which give rise to a spectral resolution E^Q in L^p . Then $P_p \in O_p$. In the case $p = 2$, the relation $P_2 \in O_2$ comes from the spectral theorem (O_2 contains all self-adjoint linear transformations of L^2). Differential transformations of a more general sort also belong to O_p .

1804

Purdue U. [Dept. of Mathematics] Lafayette, Ind.

NORMAL OPERATORS ON THE BANACH $L^p(-\infty, \infty)$. PART II. UNBOUNDED OPERATORS, by G. L. Krabbe. Nov. 20, 1959, 36p. incl. refs. (AFOSR-TN-59-1212) (AF 49(638)505) AD 231841; PB 145933 Unclassified

Also published in *Jour. Math. and Mech.*, v. 10: 111-133,
Jan. 1961.

Let $1 < p < \infty$. The differentiation operator D_p is defined by $D_p x =$ derivative of x for all functions x in the set $d(D_p)$ of locally absolutely continuous members of $L^p = L^p(-\infty, \infty)$ whose derivative lies in L^p . Let O_p be the class of all linear operators T_p on L^p which have a spectral resolution E_p^T such that the relation $T_p x = \int \theta \cdot E_p^T(d\theta)x$ holds for all x in the domain $d(T_p)$ of T_p . O_p is shown to contain the operator $\nabla_p = (i/2\pi)D_p$. A class \mathbb{T}_p is defined such that $\nabla_p \in \mathbb{T}_p \subset O_p$. The class \mathbb{T}_p contains an algebra of different operators and the operator $D_p H_p$, where H_p is the Hilbert transformation. (Contractor's abstract)

1805

Purdue U. [Dept. of Physics] Lafayette, Ind.

MUON CAPTURE IN CERTAIN LIGHT NUCLEI, by A. Fujii and H. Primakoff. Mar. 1959 [29]p. incl. refs. (Technical rept. no. 20) (AFOSR-TN-59-28) (In cooperation with Washington U., St. Louis, Mo., AF 18(603)-108) (AF 18(600)1579) AD 208873 Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

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Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 39, Jan. 28, 1959.

Also published in Nuovo Cimento, Series X, v. 12: 327-355, May 1, 1959.

The partial transition rate of the muon-capture reactions $\text{He}^3 \rightarrow \text{H}^3$, $\text{Li}^6 \rightarrow \text{He}^6$, and $\text{C}^{12} \rightarrow \text{B}^{12}$ in which the daughter nucleus is found in its ground state is calculated by making use of the comparison with the beta-decay transition rate of the daughter nucleus from the ground state back to the ground state of the parent nucleus. Also the universality in coupling constants and coupling schemes, V-A between beta decay and muon capture is assumed. The "induced" pseudoscalar interaction and the correction due to "divergenceless" current are both included in the basic Hamiltonian. The nuclear matrix element is evaluated using a variational trial wave function for He^3 and an oscillator potential wave function in LS and jj coupling shell theory for Li^6 and C^{12} , respectively. The calculated partial capture rate is in agreement with experiment which exists only for C^{12} at present. (Same as item no. 2174).

1806

Purdue U. [Dept. of Physics] Lafayette, Ind.

ON THE EVALUATION OF DISPERSION RELATIONS, by R. Blankenbecler and S. Gartenhaus. [1959] 30p. incl. refs. (AFOSR-TN-59-534) (AF 18(600)1579) AD 216551; PB 142403 Unclassified

Also published in Phys. Rev., v. 116: 1297-1305, Dec. 1, 1959.

A new evaluation of the dispersion relations for mesonic phenomena is proposed. The method, which utilizes the comparison function procedure, makes explicit use of crossing symmetry and allows for an exact treatment of nuclear recoils. For the case of meson nucleon scattering at low energies an expansion of a first order solution is made in inverse powers of the nucleon mass and agreement with the results of a previous evaluation is obtained. The extension of the method to other processes is briefly discussed. (Contractor's abstract)

1807

Purdue U. [Dept. of Physics] Lafayette, Ind.

PHOTOPRODUCTION OF PI-MESONS, by S. Gartenhaus and R. Blankenbecler. [1959] [23]p incl. diagrs. (AFOSR-TN-59-1027) (AF 18(600)1579) AD 250976 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 49, Jan. 29, 1959. (Title varies)

Also published in Phys. Rev., v. 116: 1305-1311, Dec. 1, 1959.

The dispersion relations for meson photoproduction at moderately low energies are examined by means of the comparison function method which was proposed in an earlier paper. Assuming that only the (3,3) state is appreciably modified by rescattering effects, an approximate solution is obtained. Nucleon recoil and crossing symmetry are treated exactly. The static limit of this solution yields substantial agreement with the results of Chew, Goldberger, Low, and Nambu (Phys. Rev., v. 106: 1345, 1957). It is hoped that an evaluation including effects of nucleon recoil will improve the agreement in the resonance region. (Contractor's abstract)

1808

Purdue U. [Dept. of Physics] Lafayette, Ind.

ELECTRON-(ANTI)NEUTRINO SCATTERING, by R. W. King, D. C. Peaslee, and J. F. Perkins. [1959] [5]p. incl. diagr. (AFOSR-TN-59-1243) (AF 18(600)1579) AD 241632 Unclassified

Also published in Phys. Rev., v. 117: 1614-1615, Mar. 15, 1960. (Title varies)

Cross sections for electron-neutrino and electron-anti-neutrino scattering are given as a function of recoil electron energy, averaged over a reactor spectrum of anti-neutrinos. (Contractor's abstract)

1809

Purdue U. Dept. of Physics, Lafayette, Ind.

MUON CAPTURE IN He^3 , by A. Fujii. [1959] [1]p. (AFOSR-TN-59-1320) ([Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1579] and Atomic Energy Commission) Unclassified

Also published in Phys. Rev., v. 118: 870, May 1, 1960.

The hard core wavefunction for a 3-nucleon system is used to calculate the capture rate of the reaction

$\mu^- + \text{He}^3 \rightarrow \text{H}^3 (\text{ground state}) + \nu$. It is found to be $1.66 \times 10^3 \text{ sec}^{-1}$. (Contractor's abstract)

1810

Purdue U. [Dept. of Physics] Lafayette, Ind.

Σ -MIXING EFFECTS IN THE HYPERTRITON (Abstract), by M. T. Vaughn. [1959] [1]p. [AF 18(600)1579] Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
37, Jan. 28, 1959.

A variational calculation has been made to estimate the contribution of the off-diagonal (Σ mixing) terms of the A-nucleon potential to the binding of the hypertriton. Two terms were used in the semiphenomenological potential tried here: the 1st was a Σ -mixing term of Yukawa shape and range 1 pion Compton wavelength corresponding to the 2nd-order potential calculated by Lichtenberg and Ross; the 2nd term was a Yukawa potential containing both diagonal and off-diagonal terms of range $\sim \frac{1}{2}$ pion Compton wavelength (0.6f and 0.8f were used), corresponding roughly to the 4th-order potential of Lichtenberg and Ross. Tensor forces were replaced by "equivalent" central potentials throughout. For various strengths of the 2nd-order term, the strength of the 4th-order term necessary to produce the observed hypertriton binding energy was determined by a variational calculation. It was found that the Σ -mixing terms contribute 20-40% of the effective A-deuteron potential for reasonable choices of the strength of the 2nd-order potential.

1811

Purdue U. [Dept. of Physics] Lafayette, Ind.

ANGULAR MOMENTUM OF THE ELECTRON-NEUTRINO IN FIRST FORBIDDEN BETA DECAY (Abstract), by C. E. Johnson and R. W. King. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1579] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
58, Jan. 28, 1959.

The nuclear shell model and the collective model are employed to predict the presence of sizable unique ($\Delta I = 2$) components in particular classes of what are usually assumed to be non-unique first forbidden beta transitions ($\Delta I = 0 \pm 1$). The shell model argument depends only on the plausible assumption that configuration admixing is restricted primarily to configurations in the same major shell. The collective model argument depends only on the validity of the K-quantum number. Experimental evidence is surveyed to support each of these effects imposed on beta decay by the structure of the nucleus. It is proposed that first forbidden beta decay be used to explore the degree of configuration mixing in the shell model and the validity of the K-quantum number in the collective region. The analysis of several kinds of experiments will be strongly affected by the presence of the usually neglected unique components (e.g., experiments with oriented nuclei, β - γ angular correlation experiments, etc.).

1812

Purdue U. [Dept. of Physics] Lafayette, Ind.

APPLICATION OF THE QUASI- α MODEL TO BETA DECAY AND NUCLEAR MAGNETIC MOMENTS (Abstract), by D. W. Dorn and R. W. King. [1959] [1]p. [AF 18(600)1579] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
59, Jan. 28, 1959.

The quasi- α model in j-j coupling previously presented has been applied to the calculation of beta-decay matrix elements and magnetic moments in the nuclear $d_{5/2}$ and $f_{7/2}$ shells. The model (in the j-j coupling limit) need only be imposed to obtain non-unique wave functions, i.e., those wave functions for which the requirements that the total-angular momentum I and the isotopic spin T be good quantum numbers are insufficient to determine the angular parts of the wave function. Twenty-three beta transition probabilities for which experimental comparison is possible have been calculated. The degree of agreement is just that found for the cases where only unique wave functions are required. This agreement is far superior to that obtained when the criterion of seniority is imposed. The symmetry properties of the quasi- α structure are also more in accord with our knowledge of the nucleon-nucleon interaction than those implied by making seniority a good quantum number. In 10 cases comparisons were made with the calculated magnetic moments with experiment. While the agreement is good, no great improvement over other models can be claimed since magnetic moments appear rather insensitive to the choice of model.

1813

Purdue U. [Dept. of Physics] Lafayette, Ind.

LOWEST ORDER VELOCITY DEPENDENT NUCLEAR FORCE FROM PION FIELD THEORY (Abstract), by M. Sugawara, M. T. Vaughn, and S. Okubo. [1959] [1]p. [AF 18(600)1579] Unclassified

Presented at meeting of the Amer. Phys. Soc.,
Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
266, Apr. 30, 1959.

Velocity dependent 2-nucleon potential has been derived from relativistic ps-ps pion field theory up to the lowest order of both coupling and pion-nucleon mass ratio, using Tamm-Dancoff formalism. The result obtained is not the same, but of similar general feature, as the 1 obtained from ps-pv pion field theory using the same

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procedure. The detail of the derived potential will be reported, with particular emphasis on comparison of this potential with the $L \cdot S$ potential thus far proposed.

1814

Purdue U. [Dept. of Physics] Lafayette, Ind.

SEVEN-DIMENSIONAL CHARGE SPACE, by D. C. Peaslee. [1959] [14]p. incl. diagrs. tables, refs. [AF 18(600)1579] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 230, Apr. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 117: 873-886, Feb. 1, 1960.

Some implications of a charge space of 7 (rotational) dimensions are considered for (I) particle classification, (II) strong interactions, and (III) weak interactions. The principal conclusions from the point of view are that (I) all particles except the photon and graviton can be incorporated in 7 dimensional charge space; lepton conservation must be abandoned, which automatically introduces parity nonconservation into β decay; (II) the one boson, two fermion interaction is predominantly pseudovector in form and induces no mass differences; the Σ -A mass difference arises from interference with a fundamental two boson, two fermion interaction of lower symmetry; the E-N mass difference has an "intrinsic" basis and is not due entirely to strong interactions; (III) the weak universal Fermi interaction has signature -1 under time reversal; the strangeness change $\Delta S = \pm 1$ is associated with 256 independent (in principle) terms; the rule $\Delta I \neq \frac{1}{2}$ needs further qualification because $I = T + U$, where T and U are independent operators. (Contractor's abstract)



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1815

Radio Corp. of America. Astro-Electronics Div.,
Princeton, N. J.

NON-UNIFORM R.F. FIELD ACCELERATION METHODS FOR PLASMA ROCKETS (Abstract), by E. C. Hutter and G. A. Swartz. [1959] [2]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)658)

Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Investigations are being made of non-uniform RF field acceleration methods and the feasibility of such methods for use in plasma rockets for satellite and space vehicle applications. A laboratory model of a non-uniform RF field accelerator has been constructed and will be used to test general principles of 1 particular method. The model consists of a continuously pumped tube containing electrode configurations to develop a grad E which is approx linear over a distance of 10 cm. Plasma will be generated by a 5 kv vacuum arc between metallic electrodes located within the alternating field gradient.

1816

Rand Corp., Santa Monica, Calif.

AVAILABILITY OF UPPER ATMOSPHERIC AND OTHER SELECTED DATA FROM THE I. G. Y., by S. M. Greenfield. Jan. 7, 1959, 52p. incl. diagrs. refs. (Research memo. no. 2309-ARPA; Quick key rept. no. 3) (AF 49(638)500)

Unclassified

This memorandum describes the U. S. I.G.Y. data archives pertaining to the geophysics of the upper atmosphere. It then reviews the general state of knowledge and the major lines of investigation of the U. S. I.G.Y. programs in the interrelated fields of the ionosphere, aurora, cosmic rays, solar activity, and geomagnetism. The program for using rockets and satellites as scientific tools in these I.G.Y. studies is also discussed. Thorough analysis of the I.G.Y. data is necessary in order to gain better understanding of the geophysical problems investigated — in short, to realize on the investment in the I.G.Y. program. Except for one modest study, American workers are not carrying out extensive analyses of the accumulated I.G.Y. data. However, Russian and other foreign workers are performing extensive world-wide analyses of the data contributed by all nations, including the United States. (Contractor's abstract)

1817

Rand Corp., Santa Monica, Calif.

A SURVEY OF CURRENT RESEARCH IN GASEOUS

ELECTRONICS IN THE UNITED STATES, by W. H. Culver, R. Geballe, and P. Tamarkin. Jan. 7, 1959, 98p. incl. refs. (Research memo. no. 2310-ARPA; Quick key rept. no. 4) (AF 49(638)500) AD 243952

Unclassified

This memorandum outlines the relation of atomic and ionic impact phenomena to the propagation of electromagnetic waves in the upper atmosphere. Several group efforts are described which are aimed at stimulating research on impact phenomena and related fields in gaseous electronics. Descriptions are given of current and projected research in principal laboratories in the United States. The status of the research is summarized and suggestions for further research are presented. (Contractor's abstract)

Reaction Motors, Inc., Denville, N. J. see

Thiokol Chemical Corp. Reaction Motors, Inc., Denville, N. J.

1818

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

NONEQUILIBRIUM FLOW IN GAS DYNAMICS, by T.-Y. Li. May 1959, 68p. incl. diagrs. refs. (Rept. no. TR-AE-5901) (AFOSR-TN-59-389) (AF 18(600)1591) AD 213893; PB 143516

Unclassified

General concepts are given which include: (1) the fundamental equations and boundary conditions in problems of steady adiabatic inviscid flow of a reacting mixture of perfect gases and (2) a general study of the chemical relaxation in a gaseous system. The steady 1-dimensional nozzle flow with nonequilibrium chemical reactions is next considered. An important nondimensional parameter is used to classify the nozzle flow into equilibrium flow, nonequilibrium flow, and frozen flow. Significant departure from equilibrium flow in a hypersonic shock tunnel nozzle would lead to frozen flow further downstream. Also presented is a numerical method whereby the inviscid adiabatic flow of a reacting mixture of perfect gases past a blunt body may be calculated. Numerical examples show that significant changes in the flow conditions of the shock layer region can be attributed to the chemical nonequilibrium effects.

1819

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

EXPLORATORY EXPERIMENTAL STUDY OF A NEW METHOD OF ENERGY EXCHANGE BETWEEN STEADY FLOWS, by W. J. Guman. May 1958, 56p. incl. illus. diagrs. tables. (Rept. no. TR-AE-5811) (AFOSR-TN-59-14) (AF 18(603)37) AD 208595; PB 140152

Unclassified

A summary is given of an experimental investigation of a new energy transfer mode set forth by an exploratory

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study of radial-flow air-to-air induction by pseudo-blades in free-rotor models. Test results showing the effects of various gasdynamic and geometrical parameters are presented. Results of limited flow visualization studies are also discussed. (Contractor's abstract)

1820

Rensselaer Polytechnic Inst. [Dept. of Aeronautical Engineering] Troy, N. Y.

[METHOD AND APPARATUS FOR INDUCING FLUID FLOW]. Final rept. 1959 [3]p. (AFOSR-TR-59-140) (AF 18(600)37) Unclassified

The purpose of this project was to design and build an experimental model to demonstrate the flow induction phenomena predicted for the energy exchange between flows. The model was constructed and instrumented to permit (1) measurements leading to an estimation of the rate and amount of mixing of the flow inducing blades, and (2) a determination of the blade shape, size, and flow induction capability. The difficulties encountered allowed only 2 rotor passages to be built and tested. Although they performed differently, the interacting flows of each maintained their separate identities over an appreciable distance. It soon became evident that secondary-flow patterns were generated in the driving flow by a succession of bends to which this flow was subjected within the rotor. An attempt was made to circumvent these difficulties by studying, in parallel with the main effort, the possibility of generating a pattern of primary pseudo-blades by utilization of a modified and controlled form of rotating stall through stationary cascades. No significant results have yet been made public of these efforts.

1821

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

A STUDY OF THE USE OF OPTIMAL COORDINATES FOR SOME VISCOUS FLOW PROBLEMS, by K. T. Yen. Apr. 1958, 43p. incl. diagr. (Rept. no. TR-AE-5805) (AFOSR-TN-59-11) (AF 49(638)23) AD 208592 Unclassified

A study of the use of optimal coordinates for (a) boundary layer flows of the wedge type and (b) a simple shear flow over a flat plate is made. It is shown that, for these problems, optimal coordinates can be found to achieve smooth transition from the inner viscous flow to the "outer" free stream flow. The significance of these coordinates and some features of the physical problems are discussed. In particular, the boundary layer problem of a flat plate is considered in some detail: a new definition of boundary layer thickness is proposed and some points concerning the properties of the Blasius solution and the boundary layer solution in parabolic coordinates are discussed. For the simple

shear flow it is shown that parabolic coordinates can be used as the optimal coordinates. Two methods of solution for this problem with vorticity index $\omega_0 \sim 1$ and $\omega_0 \ll 1$, respectively, are given. (Contractor's abstract)

1822

Rensselaer Polytechnic Inst. Dept. of Aeronautical Engineering, Troy, N. Y.

ON THE THRUST HYPOTHESIS FOR THE JET FLAP INCLUDING MIXING EFFECTS, by K. T. Yen. June 1959, 47p. incl. diagrs. refs. (Rept. no. TR-AE-5902) (AFOSR-TN-59-737) (AF 49(638)23) AD 225014; PB 143159 Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 607-614, Aug. 1960.

An investigation of thrust generated by a jet flap shows that a linear thrust hypothesis can be obtained, provided linearized potential flow is assumed. In fact, the linearized problem of a jet flap system is found to be the linear combination of a lift problem and a thrust problem. The lift problem gives all the lift generated, but it is of interest to note that the thrust problem would yield all the thrust developed by the jet flap within the limitation of the linearized theory. The mixing of the jet flap with the surrounding fluid is analyzed by the momentum integral method. The analysis substantiates Stratford's suggestion (Aeronaut. Quart., v. 7: 85-105, May 1956) for obtaining an increase of thrust by causing the jet to mix with the main stream in a region of high suction. Finally, some approximate formulas, relating the thrust and the jet angle are derived. (Contractor's abstract)

1823

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

STRUCTURE OF MOLTEN MERCURIC HALIDES, by J. D. E. McIntyre and G. J. Janz. Mar. 1959 [27]p. incl. diagrs. tables, refs. (Technical note no. 10) (AFOSR-TN-59-310) (AF 49(638)50) AD 213242; PB 140582 Unclassified

Presented at Symposium on Molten Salts, New York Acad. Sci., Apr. 1959.

Also published in Ann. New York Acad. Sci., v. 79: 790-802, Jan. 30, 1960.

The physical properties and structures of the mercuric halides for the solid, gaseous, and liquid states are reviewed. Two models for the liquid state are proposed, 1 due to complete self-dissociation with the formation of the complex ions, Hg X^+ and Hg X_3^- , as the predominant species, and the 2nd in which the molten salt consists primarily of the molecular

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species, Hg X_2 . The evidence of electrical conductance and viscosity is examined in the light of both models, using HgBr_2 as example. The percentage of ions free to conduct on this melt is shown to be 2×10^{-2} . The conditions under which calculations of the degree of ionic dissociation by the concept of reduced conductance for molten salts are discussed. (Contractor's abstract)

1824

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

FUSED SALT CHEMISTRY, by G. J. Janz. Aug. 1959 [29]p. incl. diagrs. tables, refs. (Technical note no. 11) (AFOSR-TN-59-880) (AF 49(638)50) AD 226418; PB 143924 Unclassified

Also published in Proc. Internat'l. Symposium on High Temperature Tech., Asilomar, Calif. (Oct. 6-9, 1959), New York, McGraw-Hill, 1960, p. 278-295.

Molten salts form systems which are liquid at temperatures up to 3000°C at atmospheric pressure. They form the largest class of non-aqueous inorganic solvents. The present communication develops some aspects of the structure of molten salts which are of current interest among both theoretical and experimental research workers. The models for molten salts based on liquid state theories and on the electro-chemical properties of these systems are considered. Experimental methods, the information to be gained, and current problems in the fields of pure molten salts, and mixtures are surveyed. (Contractor's abstract)

1825

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

AN ELECTRONIC RECORDING DIFFERENTIAL POTENTIOMETER, by C. Solomons and G. J. Janz. [1959] [1]p. incl. diagr. (AFOSR-3801) (AF 49(638)50) Unclassified

Also published in Anal. Chem., v. 31: 623, Apr. 1959.

This paper reports on the construction of a thermometric device, capable of accurately measuring small changes of temperature over a wide temperature range (0° to 600°C), and of automatically recording the temperature-time changes. The component units of the present design include a potentiometer, a microvolt amplifier, and a strip-chart recorder. A detailed explanation of the principles of operation is given. The advantages of this design include its simplicity, sensitivity, and versatility over earlier designs.

1826

Rensselaer Polytechnic Inst. Dept. of Chemistry, Troy, N. Y.

STRUCTURE OF MOLTEN MERCURIC HALIDES. II. HEAT AND ENTROPY OF FUSION OF MERCURIC BROMIDE, by G. J. Janz and J. Goodkin. [1959] [2]p. incl. table, refs. (AF 49(638)50) Unclassified

Published in Jour. Phys. Chem., v. 63: 1975-1976, Nov. 1959.

It is shown that the heat of fusion of HgBr_2 at $238.1^\circ = 4280 \pm 80$ cal/mol by drop calorimetry. It is also shown that $\Delta S_{238.1} = 8.4$ eu.

1827

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

PROBLEMS IN THE DYNAMICS OF ELASTIC SYSTEMS UNDER INITIAL STRESS, by Y.-O. Tu and G. Handleman. May 8, 1959, 74p. incl. diagr. tables, refs. (Math. rept. no. 25) (AFOSR-TN-59-406) (AF 18(600)-1586) AD 214503; PB 142229 Unclassified

The eigenvalue problems associated with vibration and stability of beams under initial axial stress and flat plates under initial plane stress are formulated from variational principles for general structural members. These eigenvalue problems can be studied by means of variational principles or through the solution of appropriate differential equations with corresponding boundary conditions. Approximate solutions for small γ^2 can be obtained by the perturbation theory of Rellich for which the perturbed differential operator is of lower order than the unperturbed problem. If, however, the beam is everywhere under tension, no critical load exists. Consequently, γ^2 could be very large, and β^4 increases monotonically with respect to γ^2 . By writing the differential equation in the form $[\psi(x)u']' + (1/\gamma^2)u^{iv} = (\beta^4/\gamma^2)u$, an approximate solution can be found for large γ by the method of singular perturbation for which the perturbed differential operator is of higher order than the unperturbed one. Perturbation solutions have been carried out for another example of a thin, but long, flat plate simply supported on all edges and subjected to parabolic temperature distribution along its width. Numerical results do indicate the existence of critical loads. (Contractor's abstract)

1828

Rensselaer Polytechnic Inst. Dept. of Mathematics, Troy, N. Y.

LINEAR DIFFERENTIAL EQUATIONS WITH RANDOM

AIR FORCE SCIENTIFIC RESEARCH

NONHOMOGENEITIES, by W. E. Boyce. Dec. 17, 1959 [11]p. incl. diagr. (Math. rept. no. 29) (AFOSR-TN-59-1260) (AF 18(600)1586) AD 230946; PB 153382
Unclassified

A method is proposed for dealing with the effects of certain types of random perturbations in systems governed by linear differential equations. When these perturbations occur as a nonhomogeneous term in the differential equation, the solution can be represented by means of an integral involving the random nonhomogeneity, both for boundary and initial value problems. This integral can be commuted with the integrals representing statistical moments, and several consequences of this fact are discussed. (Contractor's abstract)

1829

Rensselaer Polytechnic Inst. [Dept. of Mathematics]
Troy, N. Y.

A NOTE ON STRAIN HARDENING CIRCULAR PLATES, by W. E. Boyce. [1959] [12]p. incl. diagrs. (AF 18-(600)1586) Unclassified

Published in Jour. Mech. and Phys. Solids, v. 7: 114-125, Mar. 1959.

Previous solutions for uniformly loaded simply supported circular plates are extended to plates which are partially clamped. A piecewise linear theory using Prager's hardening law is employed. The effect of perturbations in the initial yield stress on the post-yield stresses and displacements is also examined. (Contractor's abstract)

1830

Rensselaer Polytechnic Inst. Dept. of Mathematics,
Troy, N. Y.

HARMONIC AND SUBHARMONIC RESPONSE OF AN ON-OFF CONTROL SYSTEM TO SINUSOIDAL INPUTS, by B. A. Fleishman. May 7, 1959 [29]p. incl. diagrs. (Math. rept. no. 24) (AFOSR-TN-59-360) (AF 49(638)-514) AD 213670 Unclassified

Also published in Jour. Franklin Inst., v. 270: 99-113, Aug. 1960.

Periodic solutions are derived, of harmonic and subharmonic type, of a differential equation governing the operation of a relay servomechanism which is subjected to a sinusoidal input $y_0 \sin \omega t$. Each solution is a "formal" solution in the sense that it is constructed under an a priori assumption about the manner in which it changes sign, and this assumption can be verified only after one has the solution. A significant part of the analysis, then, is devoted to the determination of suitable conditions on the parameters y_0 and ω which insure the validity of the formal solution. (Contractor's abstract)

1831

Rensselaer Polytechnic Inst. Dept. of Mathematics,
Troy, N. Y.

A GENERALIZATION OF THE PHASE RELATIONS IN A FORCED HARMONIC OSCILLATOR, by B. A. Fleishman. Dec. 18, 1959 [11]p. incl. diagrs. (Math. rept. no. 30) (AFOSR-TN-59-1178) (AF 49(638)514) AD 232437; PB 145999 Unclassified

Also published in Jour. Franklin Inst., v. 272: 360-365, Nov. 1961.

When a simple harmonic oscillator is subjected to a sinusoidally varying external force whose frequency is different from the natural frequency of the oscillator, there is a simple and wellknown phase relation between the purely forced response and the forcing function. They will have the same or opposite signs (except when both functions vanish) according as the forcing frequency is less or greater than the natural frequency. It is shown here that when the sinusoidal forcing function is replaced by any member of a wide class of periodic functions, the relation between the signs of the forcing function and the forced response continues to hold when the forcing frequency is greater than the natural frequency, but no longer holds in the other case. (Contractor's abstract)

1832

Rensselaer Polytechnic Inst. [Dept. of Mathematics]
Troy, N. Y.

A COMPUTATIONAL PROOF PROCEDURE. AXIOMS FOR NUMBER THEORY. RESEARCH ON HILBERT'S TENTH PROBLEM, by M. Davis and H. Putnam. Oct. 1959, 1v. incl. refs. (AFOSR-TR-59-124) (AF 49-(638)527) AD 240066; PB 144296 Unclassified

A computing procedure for quantification theory: A refutation algorithm is described whereby, given an inconsistent formula, a proof of inconsistency is obtained which may also be regarded as a proof of validity for the negation of the given formula. A finitely axiomatizable system for elementary number theory: Let Z be the formalization of elementary number theory, using Peano's postulates and the recursive equations for addition and multiplication. A system EZ , formalized within quantification theory, is constructed. On Hilbert's tenth problem: Hilbert's tenth problem is the problem of finding an algorithm for determining, given a diophantine equation, whether or not it has a solution. Several theorems are established bearing on a related problem which arises if the diophantine equation is taken in the following sense: equation of the form $P = 0$, where P is a polynomial whose exponents may themselves be variables as well as constants, to be solved in integers.

AIR FORCE SCIENTIFIC RESEARCH

1833

Rensselaer Polytechnic Inst. Dept. of Mechanics,
Troy, N. Y.

ON THE ELASTIC IMPACT OF SHORT CYLINDRICAL
RODS ON LONG CYLINDRICAL RODS, by C. S. Barton
and E. G. Volterra. [1959] [13]p. incl. diagrs. table.
(AF 49(638)19) Unclassified

Published in Proc. Fourth Midwestern Conf. on Solid
Mech., Texas U., Austin (Sept. 9-11, 1959), Austin,
Texas U. Press, 1959, p. 318-330.

This paper presents the results of experiments carried
out on the longitudinal elastic impact of short cylindri-
cal steel rods (with lengths which varied from 2.54 cm
to 100 cm) on very long cylindrical rods. The heights
of drop of the impinging bars varied from 2.5 to 10 cm
while the diam of the impacted and impinging bars were
of 1 in. The electronic circuitry and the equipment
used are described. Experimental results obtained are
compared in graph form with the theoretical results de-
duced by applying Hertz's elastic theory of impact.
(Contractor's abstract)

1834

Republic Aviation Corp. Plasma Propulsion Lab.,
Farmingdale, N. Y.

OPTIMUM POWER GENERATION FROM A MOVING
PLASMA, by J. L. Neuringer. Apr. 1959 [23]p. incl.
diagrs. table. (SRS(PPL) rept. no. 105) (AFOSR-TN-
59-515) (AF 49(638)552) AD 216280; PB 144491
Unclassified

Also published in Jour. Fluid Mech., v. 7: 287-301,
Feb. 1960.

Solutions for the compressible generator are obtained
for only 1 particular value of the entrance Mach num-
ber. It is planned to obtain a family of solutions over
a wide Mach number range. Interest here is not only
toward the determination of the effect on the interaction
of the various states of compressibility of the entering
plasma, but to see whether the cuspidal behavior occurs
for other Mach numbers as well, and at what values of δ . The physical significance, if any, of the cuspidal be-
havior itself should be investigated. Some analysis
should be made into the asymptotic behavior of the solu-
tion for limiting values of M_0 and δ ; for there may exist
some combination of finite values of M_0 and δ which
would give an overall maximum efficiency. A thorough
examination should be made into the validity of the as-
sumptions made in section 1 directed towards estimat-
ing the practicality of the results. In particular, the ef-
fect of the possible development of space charge and the
formation of space charge sheaths near the walls should
be thoroughly investigated. In conclusion, it is hoped
that, while this paper concerned itself mainly with the
theoretical treatment of a very highly idealized but in-

teresting problem in hydromagnetics, it will also serve
in giving a 1st insight into the behavior of a type of gen-
erator which may prove to have future practicality.
(Contractor's abstract)

1835

Republic Aviation Corp. Plasma Propulsion Lab.,
Farmingdale, N. Y.

OPTIMUM POWER GENERATION USING A PLASMA AS
THE WORKING FLUID, by J. L. Neuringer. May 1959
[50]p. incl. diagrs. tables. (SRS(PPL) rept. no. 114)
(AFOSR-TN-59-571) (AF 49(638)552) AD 245868;
PB 144490 Unclassified

Also published in Proc. Third Biennial Gas Dynamics
Symposium on Dynamics of Conducting Gases, Evan-
ston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern
U. Press, Mar. 1960, p. 153-167. (AFOSR-TR-60-87)

The steady one-dimensional motion of a plasma is con-
sidered in a channel of arbitrary and slowly varying
cross section. The plasma flows across a transverse
magnetic field of arbitrarily varying strength, and the
conducting channel walls are connected to an external
resistive load of arbitrary magnitude. The extremum
problem is formulated using the techniques of the calcu-
lus of variations to obtain the appropriate system of dif-
ferential equations and boundary conditions. For the
special cases where the differential constraints i.e. the
fluid flow equations, are integrable, analytical solutions
are obtained exhibiting the dependence of the required
loading on the Magnetic Reynolds number and the flow
Mach numbers based on the sonic and Alfvén wave
speeds. The power, electrical conversion efficiency,
terminal voltage, and distribution of the fluid mechani-
cal variables along the channel are also presented as
functions of the above dimensionless parameters. (Con-
tractor's abstract)

1836

Republic Aviation Corp. Plasma Propulsion Lab.,
Farmingdale, N. Y.

PLASMA PINCH ENGINE. THE PROBLEM OF RE-
PEATED PINCHES (Unclassified title), by A. E. Kunen,
I. Granet, and W. J. Guman. Sept. 1959, 16p. incl.
diagrs. tables. (AFOSR-TN-59-1337) (Sponsored joint-
ly by Air Force Office of Scientific Research under
AF 49(638)552 and Office of Naval Research under
Nonr-285100) Confidential

1837

Republic Aviation Corp. Plasma Propulsion Lab.,
Farmingdale, N. Y.

THE ELECTROMAGNETIC PINCH EFFECT FOR
SPACE PROPULSION, by A. E. Kunen and W. McIlroy.

AIR FORCE SCIENTIFIC RESEARCH

Aug. 1959, 22p. incl. illus. diagrs. table, refs. (PPL rept. no. 116) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)552 and Office of Naval Research under Nonr-285100) AD 266981

Unclassified

Also published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, Mar. 1960, p. 178-189. (AFOSR-TR-60-87)

The phenomenon of the electromagnetic pinch effect is used to accelerate ionized gases for space propulsion. Electrical energy, initially stored in capacitors, is discharged across two nozzle shaped electrodes wherein the radial pinch is converted to axial motion of the affected gases instead of confinement at the axis. The gas dynamics of a pinch using the hydrodynamical model of a "magnetic piston" driving a shock wave, is combined with the electrodynamics of the circuit to calculate the behavior of the discharge. Experiments on three different electrode designs are discussed and the results obtained are compared with the calculated values. The results of the study are applied to one particular space propulsion system consisting of a nuclear energy source, a space radiator, a turbine-generator, capacitor, and a pinch tube. The specific mission analyzed is a one-way unmanned flight to a Mars orbit, starting from an Earth orbit.

1838

Republic Aviation Corp. [Plasma Propulsion Lab.] Farmingdale, N. Y.

ELECTROMAGNETIC ACCELERATION OF PLASMA FOR SPACE PROPULSION, by A. Schock. [1959] [20]p. incl. illus. table. (Rept. no. PPL-118) (AF 49(638)552) AD 267236

Unclassified

Four methods are described for analyzing the dynamic behavior of plasma accelerators: the gas-dynamic, the snow-plow, the free particle, and the slug model. The latter method is examined in detail, and it is demonstrated that approximate solutions exist which aid in predicting the effect of various parameters on performance. The use of this analytical model in designing the system and the mode of operation can lead to favorable efficiencies in converting electrical to kinetic energy. (Contractor's abstract)

1839

Republic Aviation Corp. [Plasma Propulsion Lab.] Farmingdale, N. Y.

PART I. ELECTROMAGNETICALLY INDUCED CHEMICAL REACTIONS. PART II. POWER GENERATION USING A PLASMA AS THE WORKING FLUID (Abstract), by W. McIlroy. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)552)

Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Part I. The electromagnetic constriction of gases between 2 electrodes (pinch effect) when a capacitor is suddenly discharged across these electrodes is discussed. The gas dynamical behavior is coupled with the electrical circuit dynamics to calculate the resultant pinch. Theoretical and experimental results are compared. The pinch effect is discussed with a chemically reacting mixture of gases admitted between the electrodes. The gas dynamic model is that of a cylindrical "magnetic piston" progressing towards the axis of the electrodes and driving ahead a detonation wave, thereby releasing chemical energy. Part II. The problem of optimum power generation from a plasma moving through magnetic fields is discussed.

1840

Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.

THE PLASMA PINCH ENGINE, by A. E. Kunen, I. Granet, and W. J. Guman. [1959] [10]p. incl. diagrs. tables. [AF 49(638)552]

Unclassified

Published in Proc. Second Symposium on Advanced Propulsion Concepts, Boston, Mass. (Oct. 7-8, 1959), Boston, v. 1: 89-98, 1959. (AFOSR-637)

The phenomenon of the electromagnetic pinch effect is used to accelerate ionized gases for space propulsion. Electrical energy is discharged across two nozzle shaped electrodes wherein the radial pinch is converted to axial motion of the affected gases instead of confinement at the axis. Pertinent parameters that can affect the mode of operation of a pinch engine are categorized. Three analytical models are used for analyzing the radial pinch plasma engine and the results are compared with each other for two sets of system variables of interest. A study has been made for application of an electrical propulsion system to two specific space missions; i.e., satellite control, and a one-way unmanned flight to a Mars orbit. (This is an unclassified version of AFOSR-TN-59-1337, item no. 1836)

1841

RIAS, Inc., Baltimore, Md.

ON THE BEHAVIOR OF THE SOLUTIONS OF LINEAR PERIODIC DIFFERENTIAL SYSTEMS NEAR RESONANCE POINTS, by J. K. Hale. [1959] [55]p. incl. refs. (Technical rept. no. 58-13) (AFOSR-TN-59-12) (AF 49(638)382) AD 208593; PB 140042

Unclassified

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 55-89, 1959.

AIR FORCE SCIENTIFIC RESEARCH

A method of successive approximation which assumes that the basic frequencies of the imperturbed system are not in resonance with the frequency of the periodic disturbance is applied to a discussion of the solutions of linear periodic systems. The linear periodic systems are reviewed for solution in the important case when the frequencies of the imperturbed equation are in resonance with the frequency of the periodic disturbance. This case is very important for determining the stability of a periodic solution of a system of nonlinear differential equations.

1842

RIAS, Inc., Baltimore, Md.

A NEW APPROACH TO LINEAR FILTERING AND PREDICTION PROBLEMS, by R. E. Kalman. [1959] [11]p. incl. diagrs. table, refs. (Monograph no. 60-11) (AFOSR-TN-59-268) (AF 49(638)382) AD 238405
Unclassified

Also published in Jour. Basic Eng., v. 82: 35-45, Mar. 1960.

The classical filtering and prediction problem is re-examined using the Bode-Shannon representation of random processes and the "state-transition" method of analysis of dynamic systems. New results are: (1) The formulation and method of solution of the problem apply without modification to stationary and non-stationary statistics and to growing-memory and infinite-memory filters. (2) A nonlinear differential equation is derived for the covariance matrix of the optimal estimation error. From the solution of this equation the coefficients of the differential equation of the optimal linear filter are obtained without further calculations. (3) The filtering problem is shown to be the dual of the noise-free regulator problem. The new method developed here is applied to two well-known problems, confirming and extending earlier results. The discussion is largely self-contained and proceeds from 1st principles; basic concepts of the theory of random processes are reviewed in the appendix. (Contractor's abstract)

1843

RIAS, Inc., Baltimore, Md.

RECENT SOVIET CONTRIBUTIONS TO ORDINARY DIFFERENTIAL EQUATIONS AND NONLINEAR MECHANICS, by J. P. LaSalle and S. Lefschetz. Apr. 1959, 1v. incl. diagrs. refs. (Technical rept. no. 59-3) (AFOSR-TN-59-308) (AF 49(638)382) AD 213092
Unclassified

A summary is presented, in somewhat nontechnical language, of a few of the major areas of research and the significance of recent major Soviet contributions to differential equations and nonlinear mechanics. The areas covered are: stability of physical systems, equilibrium states, nonlinear vibrations, control systems, and mechanics. In the appendix, a brief mathematical abstract is given of the major Soviet contributions which were available in the year 1958. Authors and exact references are given for each paper and book.

librium states, nonlinear vibrations, control systems, and mechanics. In the appendix, a brief mathematical abstract is given of the major Soviet contributions which were available in the year 1958. Authors and exact references are given for each paper and book.

1844

RIAS, Inc., Baltimore, Md.

ASYMPTOTIC STABILITY IN 3-SPACE, by C. Coleman. [1959] [12]p. incl. diagrs. (AFOSR-TN-59-438) (AF 49(638)382) AD 247250
Unclassified

Also published in Contrib. Theory on Nonlinear Oscillations, v. 5: 257-268, 1960.

The system, $\frac{dx}{dt} = f^{(m)}(x) + g(x,t)$ is considered. Conditions are found to ensure the asymptotic stability of the trivial solution of $\frac{dx}{dt} = f^{(m)}(x)$ for $n = 3$. These conditions are that the origin be an attracting focus if the function $h(x_1, x_2) = x_2 f_1^{(m)} - x_1 f_2^{(m)}$ has no real zeros, and that $\frac{dr}{dt} < 0$ ($r^2 = x_1^2 + x_2^2$) on the zeros of h if they exist. It is pointed out that the 2 conditions given for asymptotic stability are usually easy to apply and in a certain sense are necessary for asymptotic stability. In addition, if $m = 1$, the 2 conditions are equivalent to the condition that the characteristic roots of the matrix of coefficients of the linear terms have negative real parts.

1845

RIAS, Inc., Baltimore, Md.

THE LOCAL THEORY OF PIECEWISE CONTINUOUS DIFFERENTIAL EQUATIONS. I. IDEAL SYSTEMS, by J. André and P. Seibert. [1959] [31]p. incl. diagrs. refs. (AFOSR-TN-59-439) (AF 49(638)382) AD 247251
Unclassified

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 225-255, 1959.

A generalization is given on notes by André and Seibert (Arch. Math., v. 7: 148-156; 157-164, 1956) concerning n -dimensional piecewise linear systems. The systems under consideration are piecewise of type C^2 and the set of discontinuity is assumed to consist of certain hypersurfaces of class C^3 . The entire sets of solutions passing through given closed subsets of a switching space is qualitatively described. In addition, systems with switching delay, distinguished from the other systems discussed by the property of the discontinuous function changing sign shortly after the trajectory has reached the switching space, rather than at the exact moment of transition, are described.

AIR FORCE SCIENTIFIC RESEARCH

1846

RIAS, Inc., Baltimore, Md.

THE APPLICATION OF A FIXED POINT THEOREM TO A VARIETY OF NON-LINEAR STABILITY PROBLEMS, by A. Stokes. [1959] [12]p. (AFOSR-TN-59-440) (AF 49(638)382) AD 247252 Unclassified

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 173-184, 1960.

A fixed point theorem for locally convex linear spaces, due to Tychonoff, is used to reduce the study of the boundedness and stability of certain n-dimensional vector differential equations to the study of the corresponding properties of related 1st-order equations. (Contractor's abstract)

1847

RIAS, Inc., Baltimore, Md.

EXISTENCE THEOREMS FOR PERIODIC SOLUTIONS OF NONLINEAR LIPSCHITZIAN DIFFERENTIAL SYSTEMS AND FIXED POINT THEOREMS, by L. Cesari. [1959] [56]p. (AFOSR-TN-59-441) (AF 49(638)382) AD 247253 Unclassified

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 115-172, 1960.

Nonlinear systems of ordinary differential equations in the complex field containing a small parameter and satisfying merely conditions of continuity, or a Lipschitz condition, are considered. Existence theorems for periodic solutions, and families of periodic solutions are proved. (Contractor's abstract)

1848

RIAS, Inc., Baltimore, Md.

ON THE STABILITY OF PERIODIC SOLUTIONS OF WEAKLY NONLINEAR PERIODIC AND AUTONOMOUS DIFFERENTIAL SYSTEMS, by J. K. Hale. [1959] [23]p. incl. refs. (AFOSR-TN-59-442) (AF 49(638)382) AD 247254 Unclassified

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 91-113, 1960.

Application is made of results from a previous report concerning the behavior of the solutions of linear periodic differential systems near resonance points. An analysis is made to determine a number of sufficient conditions for asymptotic stability. The same methods are applied to the linear variational equations for a periodic solution of an autonomous nonlinear differential system to obtain a number of sufficient conditions for asymptotic orbital stability.

1849

RIAS, Inc., Baltimore, Md.

THE TIME OPTIMAL CONTROL PROBLEM, by J. P. La Salle. [1959] [24]p. incl. diagrs. (AFOSR-TN-59-444) (AF 49(638)382) AD 247256 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 573-577, Apr. 1959.

Also published in Contrib. Theory of Nonlinear Oscillations, v. 5: 1-24, 1960.

Let $A(t)$; $B(t)$ be continuous $n \times n$, $n \times r$ matrices, respectively, $f(t)$ a continuous n vector for $t \geq 0$, x an n vector and u an r vector. Let Ω be the set of steering functions $u(t) = (u_1(t), \dots, u_r(t))$, where $u_1(t)$ is a measurable function for $t \geq 0$ satisfying $|u_1(t)| \leq 1$; Ω_0 the subset of Ω consisting of bang-bang steering functions, those $u(t)$ for which $|u_1(t)| = 1$. Let x_0 and a path $x = z(t)$ be given, let $x = x(t; u)$ be the solution of $(1) x' = A(t)x + B(t)u(t) + f(t)$ satisfying $x = x_0$ at $t = 0$; an admissible steering function $u^* \in \Omega$ is called optimal relative to Ω if, for same $t^* > 0$, $x(t^*; u^*) = z(t^*)$ and $x(t; u) \neq z(t)$ for $0 < t < t^*$ and all $u \in \Omega$. Several results are announced, among which are the following. (I) If $u^* \in \Omega_0$ is optimal relative to Ω_0 , then it is optimal relative to Ω . (II) If Ω contains an optimal steering function, then Ω_0 contains one. (III) If, for some $u \in \Omega$, $x(t; u) = z(t)$ for some $t > 0$, then Ω contains an optimal steering function u^* which is necessarily of the form $(2) u^*(t) = \text{sgn}(yX^{-1}(t)B(t))$, where $X(t)$ is a fundamental matrix solution if $x' = A(t)x$, y is an n -dimensional (row) vector and $\text{sgn}(v_1, \dots, v_r) = (\text{sgn } v_1, \dots, \text{sgn } v_r)$.

1850

RIAS, Inc., Baltimore, Md.

THE BANG-BANG PRINCIPLE, by J. P. LaSalle. Nov. 1959 [17]p. incl. refs. (Technical rept. no. 59-5) (AFOSR-TN-59-1142) (AF 49(638)382) AD 231866; PB 145770 Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 1: 493-497, 1960.

The so-called "bang-bang" principle has for sometime been an intuitive one, i.e., if a system is to be guided to an objective in minimum time with limited steering, then the optimal steering can only be achieved at all times by using the maximum steering available. The validity and extent of control that can be achieved are the main topics discussed. The system being controlled

AIR FORCE SCIENTIFIC RESEARCH

is assumed to be linear and considered as a function of the time the steering enters linearly. The coefficients need not be constants, although some aspects of the constant coefficient case are simpler. (Contractor's abstract)

1851

RIAS, Inc., Baltimore, Md.

AFTER END-POINT MOTIONS OF GENERAL DISCONTINUOUS CONTROL SYSTEMS AND THEIR STABILITY PROPERTIES, by J. Andre and P. Seibert. [1959] [4]p. incl. refs. (AFOSR-TN-59-1150) (AF 49(638)382) Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (U.S.S.R.), 1960.

Also published in Automatic and Remote Control, v. 2: 919-922, 1960.

In this paper application is made of the results of previous research on problems of stability and asymptotic behavior. A review of these earlier results is first given in 2 sections. The first deals with "ideal" systems (in which the physical effect of switching delay is neglected) and the second deals with the switching delay and also discusses end-point motion. The basic stability theorem, according to which, a system with switching delay is stable at the origin if the corresponding system with infinitesimal switching delay has this property, is discussed. An application of this theorem is given and it is shown that every solution starting in a certain domain around the origin tends to a limit cycle near the state of equilibrium. Rough formulas for the period and amplitude of this periodic solution are given.

1852

RIAS, Inc., Baltimore, Md.

PROBLEMS OF ASYMPTOTIC BEHAVIOR AND STABILITY, by L. Cesari. [1959] [6]p. incl. refs. (AFOSR-TN-59-1176) (AF 49(638)382) Unclassified

Presented at Pacific General meeting of the Amer. Inst. Elec. Engineers, San Diego, Calif., Aug. 8-12, 1960.

Also published in Trans. Amer. Inst. Elec. Engineers, v. 80: (Pt. II) 161-166, 1961.

A discussion is presented on a number of areas in nonlinear differential equations which appear to be of heightened interest. Some of the subjects considered are points of equilibrium and their stability in the small, second method of Lyapunov and stability in the large, periodic solutions, families of periodic solution, and almost periodic solution. Primarily nonlinear differential systems of the form $\dot{x} = f(x, t)$ are considered or, in the autonomous case, of the form $\dot{x} = f(x)$.

1853

RIAS, Inc., Baltimore, Md.

A NOTE ON THE CONTINUITY OF CHARACTERISTIC EXPONENTS, by J. C. Lillo. [1959] [4]p. (Monograph no. 60-7) (AFOSR-TN-59-1177) (AF 49(638)382) AD 236448 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 46: 247-250, Feb. 1960.

A new number which is called the major characteristic exponent, written $\lambda(A)$, is introduced for the system $\dot{x} = A(t)x$ where $A(t) \in M_n$. Here $\|A\| = \text{l.u.b. } \|A(t)\|$ $t \in R$

where R may be taken as either the real line or the positive real half line, $\|A(t)\| =$

$\sum_{i,j=1}^n |a_{ij}(t)|$, and M_n is the set of all continuous $n \times n$

matrices $A(t)$ whose norms are finite. It is shown that for any $A \in M_n$, $\lambda(A)$ is upper semicontinuous with respect to the norm. A number of perturbation results are given which are straightforward generalizations of known results.

1854

RIAS, Inc., Baltimore, Md.

LIAPUNOV'S FUNCTION AND BOUNDEDNESS OF SOLUTIONS, by T. Yoshizawa. Dec. 1959 [10]p. (Technical rept. no. 59-7) (AFOSR-TN-59-1218) (AF 49(638)382) AD 231861; PB 146151

Unclassified

Presented at Symposium on Ordinary Differential Equations, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 146-151, 1960.

A system of differential equation $\frac{dx}{dt} = F(t, x)$ is considered where x denotes an n -dimensional vector and $F(t, x)$ is a given vector field which is defined and continuous in a domain. Let $x = x(t; x_0, t_0)$ be a solution of $\frac{dx}{dt}$ through the initial point (t_0, x_0) . The solution for $t \geq t_0$ is considered.

1855

RIAS, Inc., Baltimore, Md.

CONTROLS: AN APPLICATION OF THE DIRECT METHOD OF LIAPUNOV, by S. Lefschetz. Dec. 1959, 11p. (Technical rept. no. 59-8) (AFOSR-TN-59-1219) (AF 49(638)382) AD 231862; PB 146150

Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Presented at Symposium on Ordinary Differential Equations, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 139-143, 1960.

The results of Lur'e, Letov, Malkin and Jakubovič on the application of the direct method of Liapunov to the generalized problem of Lur'e in the theory of control systems are described and extended. The system (F), $\dot{x} = Ax + f(\sigma)b$, $\dot{\sigma} = c'x - rf(\sigma)$ is considered, where x , b , c are n -vectors and σ , $f(\sigma)$, r are scalars. The matrix A is constant. The system $\dot{x} = Ax$ is the initial physical system, the components of x are its parameters, while σ , $f(\sigma)$ are feedback signal and characteristic. It is assumed that $f(\sigma)$ is to be continuous,

$\sigma f(\sigma) > 0$ for $\sigma \neq 0$ and $\int_0^\infty f(\sigma) d\sigma = \infty$ as $|\sigma| \rightarrow \infty$. The problem is to choose the control parameters (the components of c and the scalar r), so as to obtain asymptotic stability for all initial values x and all allowable choices of $f(\sigma)$. The solution is worked with a positive definite function (if all the characteristic roots A have negative real parts) $V(x, \sigma) =$

$x'Bx + \int_0^\sigma f(\sigma) d\sigma$, where B is the solution of the matrix equation $A'B + BA = -C$ for given $C > 0$, so that $B > 0$, as is well-known. The control parameters are now chosen so that the time derivative of V along any solution of (F), $\dot{V}(x, \sigma) = x'A'Bx + x'BAX - rf^2(\sigma) + 2f(\sigma) \{ \frac{1}{2}(b'Bx + x'Bb) + \frac{1}{2}C'x \}$, is a negative definite function of x and $f(\sigma)$. The case when A has some characteristic roots with zero real parts is also considered.

1856

RIAS, Inc., Baltimore, Md.

ON THE CHARACTERISTIC EXPONENTS OF LINEAR PERIODIC DIFFERENTIAL SYSTEMS, by J. K. Hale. Dec. 1959 [13]p. incl. refs. (Technical rept. no. 59-6) (AFOSR-TN-59-1220) (AF 49(638)382) AD 231589; PB 146149 Unclassified

Presented at Symposium on Ordinary Differential Equations, Mexico City, Sept. 1959.

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 58-66, 1960.

A new exposition is presented concerning linear systems with periodic coefficients $y' = Ay + \epsilon C(t)y$, ($y = y_1, y_2, \dots, y_N$) near systems with constant coefficients.

In principle, of course, the behavior of the solutions is described by Floquet's theory, but this description will depend on the nature of the characteristic multipliers. Here symmetries, reversibility and similar properties are shown to lead to criteria which ensure that all or some of the characteristic multipliers lie on the unit circle, in which case, boundedness is obtained for all or some solutions. The method of successive approxi-

mations is applied to a linear differential system with periodic coefficients to determine the characteristic exponents. A theorem implying asymptotic stability for weakly nonlinear systems of differential equations is also mentioned.

1857

RIAS, Inc., Baltimore, Md.

BEHAVIOR OF SOLUTIONS NEAR INTEGRAL MANIFOLDS, by J. K. Hale and A. P. Stokes. Mar. 1960 [59]p. incl. refs. (Technical rept. no. 60-10) (AFOSR-TN-59-1222) (AF 49(638)382) AD 236444; PB 147319

Unclassified

Also published in Arch. Rational Mech. Anal., v. 6: 133-170, 1960.

The behavior of the solution of the differential equation $dx/dt = Ax + f(t, x)$; $x = x_i$, $i = 1, 2, \dots, n$, $f(t, 0) = 0$, is discussed in a neighborhood of $x = 0$, where some of the roots of the constant matrix A have zero real parts, and $f(t, x)$ is small compared with x when x is small. The relationship of this system to the ones where the eigenvalues of A have nonzero real parts is given. The system of equations arises in a natural way as variational equations for invariant surfaces which consist of families of periodic solutions.

1858

RIAS, Inc., Baltimore, Md.

INTEGRAL MANIFOLDS OF PERTURBED DIFFERENTIAL SYSTEMS, by J. K. Hale. [1959] [36]p. incl. refs. (Monograph no. 61-14) (AFOSR-TN-59-1233) (AF 49-638)382) Unclassified

Also published in Ann. Math., v. 73: 496-531, May 1961.

A discussion is presented on the properties of integral manifolds of perturbed differential systems. A brief review is given of a single 2nd order differential equation $z'' + \omega^2 z = \epsilon Z(t, z, z')$, ($' = d/dt$) where $\omega > 0$, $\epsilon > 0$, $Z(t, z, z')$ is a periodic function of t of period $2\pi/\omega$, and is sufficiently smooth. The problem addressed is under what conditions is the qualitative behavior of the solution of $x' = \epsilon X(t, x)$ where $X(t, x)$ is an almost periodic function of t with frequencies ω , σ , the same as the qualitative behavior of $x' = \epsilon X_0(x)$, $X_0(x) = \lim_{T \rightarrow \infty} T^{-1} \int_0^T X(t, x) dt$. More specifically, supposing that the latter condition has an asymptotically stable equilibrium point x (which in the z, z' variables would be a periodic function of period $2\pi/\omega$), is it true that the former system has an exact solution $x = x^*(t, \epsilon)$ which is almost periodic with basic frequencies ω , σ and agrees with x when $\epsilon = 0$. This question is answered in the

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affirmative. Several proofs concerning this subject are included in this report, presented as a contrast to other results found elsewhere.

1859

RIAS, Inc., Baltimore, Md.

PERIODIC ORBITS ON TWO MANIFOLDS, by B. L. Reinhart. Jan. 1960 [7]p. incl. diag. (Technical rept. no. 60-2) (AFOSR-TN-59-1282) (AF 49(638)382) AD 233043; PB 146722 Unclassified

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 184-187, 1960.

In this note the author gives conditions under which a vector field defined on a solid torus M admits a periodic orbit lying on its surface B . The method is to exploit the concept of winding number of a regular curve of class C^1 with respect to a fixed vector field on an oriented 2-dimensional manifold. Earlier the author related the winding number of a curve and a vector field to the non-existence of periodic orbits. The result alluded to in the first sentence above is established by showing that the obstruction to sectioning a circle bundle over an appropriately chosen disk is a generator of $H^2(M; \pi_1(S^1))$. (Math. Rev. abstract)

1860

RIAS, Inc., Baltimore, Md.

A DISCUSSION OF DIFFERENTIAL EQUATIONS ON PRODUCT SPACES, by J. K. Hale and A. Stokes. Jan. 1960 [15]p. (Technical rept. no. 60-3) (AFOSR-TN-59-1283) (AF 49(638)382) AD 233044; PB 146721 Unclassified

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 67-74, 1960.

Consider the equation (1) $\dot{x} = Ax + f(t, x)$, x an n -vector, where $f(t, x) = o(\|x\|)$ as $\|x\| \rightarrow 0$, uniformly in t , and A is a constant matrix, all of whose eigen-values have negative real parts. Then the origin is asymptotically stable, and solutions beginning near the origin tend to 0 exponentially. For many reasons, it would be beneficial to know how the behavior of (1) is altered if the system is disturbed. In this case, there is the result that in the equation (2) $\dot{x} = Ax + f(t, x) + g(t, x)$, where A and f are as in (1), and $\|g(t, x)\| \leq \eta$, for $t \geq 0$, $\|x\|$ bounded, the origin is stable if η is sufficiently small. Here observe that the stability of the origin has been preserved, (even though the origin may not be a solution of (2)), but the presence of g destroys the asymptotic stability. If however, it is required that $\|g\| \leq \eta$, and $g \rightarrow 0$ as $t \rightarrow \infty$, for $\|x\|$ bounded, the origin in (2) is asymptotically stable, if η is small enough, although no longer do the solutions approach zero exponentially. In fact, if $x(t)$ is a solution, $x(t) \rightarrow 0$ as $t \rightarrow \infty$ at very

nearly the same rate as g does; for instance, if $\int_0^\infty \|g(t)\| dt < \infty$, $\int_0^\infty \|x(t)\| dt < \infty$, etc. (see H.S.). Note that if $g \rightarrow 0$ for $\|x\|$ small, as $t \rightarrow \infty$, it may be assumed $\|g\|$ small for all $t \geq 0$, or discuss the equation for $t \geq T$, where T is such that $\|g(t, x)\| \leq \eta$ for $t \geq T$. (Contractor's abstract)

1861

RIAS, Inc., Baltimore, Md.

ON THE METHOD OF KRYLOV-BOGOLIUBOV-MITROPOLSKI FOR THE EXISTENCE OF INTEGRAL MANIFOLDS OF PERTURBED DIFFERENTIAL SYSTEMS, by J. K. Hale. Jan. 1960 [13]p. incl. refs. (Technical rept. 60-1) (AFOSR-TN-59-1293) (AF 49(638)382) AD 233806; PB 146365 Unclassified

Also published in Bol. Soc. Matem. Mexicana, Series II, v. 5: 51-57, 1960.

Some important results of N. Bogoliubov and Y. Mitropolski [Asymptotic methods in the theory of non-linear oscillations, (Russian) Moscow (1955) Rev. 1958] on the existence of integral manifolds of differential systems are discussed. The results are stated in terms of a particular problem, but the proofs of these results apply to a much larger variety of questions. Only those generalizations are mentioned which are essential to make an association with some recent results of various authors in this country, and postpone a more complete discussion of the generalizations to a later paper. (Contractor's abstract)

1862

RIAS, Inc., Baltimore, Md.

THE STRUCTURE OF LOCAL HOMEOMORPHISMS, III, by S. Sternberg. [1959] [27]p. incl. refs. (AF 49(638)382) Unclassified

Published in Amer. Jour. Math., v. 81: 578-604, July 1959.

Let $V^n[U^n]$ be the group of all local C^∞ volume-preserving [respectively, volume-preserving up to a constant factor] mappings in n -space which leave the origin fixed; H^n the group of all local Hamiltonian mappings in $2n$ -space; C^n the set of all mappings given by $x_i = x_{i1} f_i(\omega)$, $\omega = x_1 \dots x_n$, with $\prod f_i = 1$ (which is proven to be a maximal commutative subgroup of V^n). Theorems: 1-4. If $T \in V^n$, $n \geq 2$, has a diagonalizable Jacobian with eigenvalues λ_i such that if $\lambda_i = \lambda_1^{m_1} \dots \lambda_n^{m_n}$, then $m_i - 1 = m_j$, $j \neq i$, there exists $R \in V^n$ such that if $RTR^{-1} \in C^n$; if $n = 2$ the same holds true under the

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additional assumption $|\lambda_1| \neq 1$; each such T lies in a one parameter group in V^n . 5-7. If $T \in U^n$ and $\lambda_1 \neq \lambda_1^{m_1} \dots \lambda_n^{m_n} \neq 1$ for all $m_j \geq 0$, $\sum m_j > 1$, there exists $R \in V^n$ such that RTR^{-1} is the linear part of T ; every such T lies in a one-parameter group in U^n . If $T \in H^n$, $|\lambda_1| \neq 1$ and $\lambda_1^{m_1} \dots \lambda_n^{m_n} \neq 1$ for all integers m_j positive or negative which are not all zero, there exists an $R \in H^n$ such that RTR^{-1} is of the form $x_1 = x_1 f_1(\omega_1, \dots, \omega_n)$, $y_i = y_i g_i(\omega_1, \dots, \omega_n)$, $\omega_i = x_i y_i$, $f_1 g_i = 1$, $\partial \log f_1 / \partial \omega_j = \partial \log g_j / \partial \omega_i$. The proofs are via corresponding theorems for formal mappings. (Math. Rev. abstract)

1863

RIAS, Inc., Baltimore, Md.

EXTERIOR DIFFERENTIAL SYSTEMS AND ELLIPTIC EQUATIONS, by B. L. Reinhart and S. Sternberg. [1959] [2]p. (AF 49(638)382) Unclassified

Published in Proc. Nat'l. Acad. Sci., v. 45: 1522-1523, Oct. 1959.

It is stated without proof that systems of elliptic partial differential equations (in the sense of Douglas-Nirenberg) give rise to exterior differential systems which are globally in involution. It is also stated as a remark of Hausner and Sternberg (unpublished) that the 2nd order parabolic, hyperbolic, and ultrahyperbolic equations give rise to exterior differential systems which are not raised to an assigned power. It is thought that the above suggests some sort of equivalence between the notions of ellipticity and involution, and also the possibility of a non-analytic theory of exterior differential systems in involution. (Math. Rev. abstract)

1864

RIAS, Inc., Baltimore, Md.

A THEORY OF SCHAEFER'S EXPANSION PATTERNS, by R. H. Aranow and L. Witten. [1959] [12]p. incl. illus. diagrs. (Monograph no. 61-13) (AFOSR-TN-59-1155) (AF 49(638)735) AD 261733 Unclassified

Also published in Jour. Colloid Sci., v. 16: 127-138, Apr. 1961.

An attempt is made to interpret theoretically the expansion patterns observed by Schaefer when an oil drop is deposited on a water surface covered with a protein layer. Schaefer observed that the line separating the oil from the protein could be smooth, rough circular, or star-shaped. The proposed interpretation involves

a type of hydrodynamic instability known as the Rayleigh-Taylor instability. Jagged or star-shaped separations indicate the presence of these hydrodynamic instabilities. They require that small perturbations of the interfacial line from smooth circular will grow rapidly with time. Since these perturbations are always present the patterns for the unstable cases will always be jagged or star-shaped. The physical criteria for the presence of these instabilities are derived, and the difference between the rough circular and star-shaped patterns is discussed. (Contractor's abstract)

1865

Rice Inst. [Dept. of Mathematics] Houston, Tex.

A NUMERICAL METHOD FOR THE SOLUTION OF A PARABOLIC SYSTEM, by J. Douglas, Jr. Feb. 9, 1960, 15p. incl. refs. (AFOSR-TN-59-1121) (AF 49(638)632) AD 232551; PB 146383 Unclassified

Also published in Numerische Math., v. 2: 91-96, 1960.

The object of this paper is to introduce a finite difference method for the approximate solution of a parabolic system of differential equations that arises in the description of 2-phase flow of incompressible fluids in a multi-dimensional porous medium. The differential system is $\nabla \cdot (\alpha u) + \nabla \cdot (\beta \nabla v) = 0$, $\nabla \cdot (\gamma \nabla u) + \nabla \cdot (\alpha \nabla v) = \frac{\partial v}{\partial t}$, where the coefficients α , β , and γ are functions of x , y , and v . The coefficients satisfy the relations (1) $M \geq \alpha(x, y, v) \geq m > 0$, (2) $|\beta(x, y, v)/\alpha(x, y, v)| \leq B < 1$, (3) $\gamma(x, y, v) \geq m > 0$. In addition, they are expected to be twice continuously differentiable. The convergence of the solution of the difference system to that of the differential system is proved. An alternating direction iteration method for solving the system of linear equations that occur at each time step is discussed also. (Contractor's abstract)

1866

Rochester U. Dept. of Chemical Engineering, N. Y.

ADHESION OF PROTECTIVE COATINGS TO METALS BY TENSILE TESTS, by G.-J. Su, T. R. Faucett, and B. Gumowski. Sept. 1959, 63p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-172) (AF 18(600)1187) AD 230751; PB 145362 Unclassified

The results discussed in the report were obtained by means of tensile tests with butt joints, using steel, brass, and aluminum as the metal substrates, and various commercial resins and coating formulations. The following factors which affect adhesion are discussed: (1) Effect of loading rate on measured bond strength. (2) Surface treatment effects on adhesion to aluminum. (3) Bond strength as a function of bond thickness. (4) Bond strength as a function of curing time for thermosetting coatings. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

1867

Rochester U. [Dept. of Chemistry] N. Y.

THE PHOTOOXIDATION OF ISOPROPYL IODIDE, by G. R. McMillan. Jan. 14, 1959, 8p. incl. tables. (AFOSR-TN-59-32) (AF 18(600)1528) AD 209204; PB 139825 Unclassified

Also published in Jour. Phys. Chem., v. 63: 1526-1528, Sept. 1959.

Experiments were performed to gain information about the reactions of the isopropyl radical with O. The photooxidation was conducted in a conventional vacuum line free of stopcocks. Oxygen was prepared by heating reagent-grade KMnO_4 , and dried by passage through a series of traps cooled in liquid N. The light source was a Hg lamp. The lines at 3130A were isolated by a filter composed of a solution of $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ and $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$, both in a 5-cm optical path, together with a 3-mm thickness of Corning Glass 9863 and 1 mm of Pyrex. In a few experiments, a thickness of 5 mm of Pyrex was used to remove all light of wavelength less than 2900A. Light intensity was varied by the use of screens. Quantum yield was based on the production of CO from the photolysis of diethyl ketone at 110°. At the end of a photolysis, residual O was pumped away and measured with all products and excess isopropyl iodide condensed in a trap cooled with liquid N. A fraction volatile at -130° was removed and analyzed with a mass spectrometer. The fraction of products not condensed at -130° contained only propylene, propane, and CO_2 .

The liquid products were isopropyl alcohol and Me_2CO . Strong heating of the quartz reaction cell and connecting tubing after a series of experiments resulted in the evolution of only traces of gas not condensed at liquid N temperature, which indicated that HgO is not a major product of the oxidation.

1868

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOLYSIS OF AMMONIA IN THE PRESENCE OF NITRIC OXIDE, by A. Serewicz and W. A. Noyes, Jr. Feb. 9, 1959, 11p. incl. tables. (AFOSR-TN-59-125) (AF 18(600)1528) AD 210430; PB 139826 Unclassified

Also published in Jour. Phys. Chem., v. 63: 843-845, June 1959.

The products of the photolysis of ammonia in the presence of nitric oxide are N_2 , N_2O , H_2O , and H_2 . The last is a minor product unless the concentration of nitric oxide is very low. A possible mechanism is proposed. (Contractor's abstract)

1869

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOCHEMICAL TYPE II PROCESS IN 2-HEXANONE-5, 5- d_2 AND 2-HEXANONE, by R.

Srinivasan. Apr. 20, 1959, 19p. incl. table, refs. (AFOSR-TN-59-423) (AF 18(600)1528) AD 214773

Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 5061-5065, Oct. 5, 1959.

The photolysis of 2-hexanone-5, 5- d_2 at 3130A and room temperature was found to give mainly $\text{C}_3\text{H}_5\text{D}$ and acetone which was a mixture of $\text{CH}_3\text{COCH}_2\text{D}$ (45%) and CH_3COCH_3 (54%). Since the course of the photolysis and the nature of the minor products were similar to that of 2-hexanone, it was surmised that acetone- d_1 , which may have been formed in the type II primary process, was subsequently exchanging the odd deuterium atom for a hydrogen atom. Such an exchange was not found to take place. The photolysis of 2-hexanone in a cell that had been exposed to D_2O vapor and then evacuated, gave rise to C_3H_6 and acetone which was made up of $\text{CH}_3\text{COCH}_2\text{D}$ (25%) and CH_3COCH_3 (75%). Pure acetone did not exchange with the D_2O on the walls under the same conditions. These results can be explained on the basis of the formation of propylene and the enolic form of acetone in the primary process, and the subsequent rearrangement of the enolic form to the ketonic form on the walls, the latter step often involving the exchange of one hydrogen (or deuterium) atom. (Contractor's abstract)

1870

Rochester U. Dept. of Chemistry, N. Y.

PHOTOISOMERIZATION PROCESSES IN CYCLIC KETONES. IV. CYCLOHEPTANONE, by R. Srinivasan. May 22, 1959, 10p. incl. tables, refs. (AFOSR-TN-59-533) (AF 18(600)1528) AD 221894 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 5541-5542, Nov. 5, 1959.

One of the products of the vapor phase photolysis of cycloheptanone at 3130A has been identified as 6-heptenal. The other products were carbon monoxide, propylene, traces of ethylene, 1-hexene and cyclohexane. Quantum yields for the formation of carbon monoxide and 6-heptenal have been obtained. The mechanism of the photochemical decomposition of cycloheptanone appears to be similar to that of cyclopentanone and cyclohexanone. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

1871

Rochester U. Dept. of Chemistry, N. Y.

PHOTOCHEMICAL STUDIES. [LV]. THE NITROUS OXIDE-ETHANE SYSTEM: LIQUID PRODUCTS AND COMPETITIVE RATES, by E. Murad and W. A. Noyes, Jr. June 19, 1959, 18p. incl. diagr. tables, refs. (AFOSR-TN-59-641) (AF 18(600)1528) AD 219173 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 6405-6408, Dec. 20, 1959.

The reactions of oxygen atoms produced by the direct photochemical decomposition of nitrous oxide with ethane have been studied. The relative rates of reaction of these atoms with ethane and with ethylene have been determined, the latter being about 330 times the former. Many of the products not volatile at -77° have been determined, although a complete material balance has not been achieved. Many steps in the complete mechanism are suggested strongly by the natures of the products and their dependence on conditions. The oxygen atoms react so much more rapidly with some of the products than they do with ethane that the over-all mechanism is very complex. (Contractor's abstract)

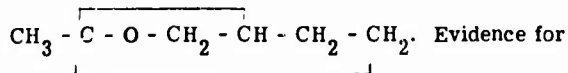
1872

Rochester U. Dept. of Chemistry, N. Y.

PHOTOISOMERIZATION OF 5-HEXEN-2-ONE, by R. Srinivasan. Aug. 24, 1959 [13]p. incl. diagr. table, refs. (AFOSR-TN-59-876) (AF 18(600)1528) Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 775-778, Feb. 20, 1960.

The photochemistry of 5-hexen-2-one has been studied in the vapor phase in the temperature range from 27° to 139° at 3130Å and also with radiation from an unfiltered mercury arc. The compound was found to be very stable towards photolysis. The most important product at 3130Å up to 139° was an isomer, the structure of which is most probably



this structure is based on the ultraviolet, infrared, nuclear magnetic resonance, and mass spectra of the product. The only other product at 3130Å that was identified was carbon monoxide. At shorter wavelengths, in addition to these products, methane, C_2 and C_3 hydrocarbons, acetone and biacetyl were identified.

Although the ultraviolet absorption spectrum of 5-hexen-2-one resembles that of 2-hexanone, its photochemical stability is similar to that of unsaturated carbonyl compounds with the double bond conjugated with the carbonyl group. (Contractor's abstract)

1873

Rochester U. Dept. of Chemistry, N. Y.

THE PHOTOLYSIS OF AMMONIA (N^{15}H_3) IN THE PRESENCE OF NITRIC OXIDE, by R. Srinivasan. Nov. 13, 1959 [7]p. incl. diagr. (AFOSR-TN-59-1196) (AF 18(600)1528) Unclassified

Also published in Jour. Phys. Chem., v. 64: 679-680, May 1960.

It was observed by Serewicz and Noyes (Jour. Phys. Chem., v. 63: 843-845, June 1959) that the photolysis of ammonia in the presence of nitric oxide led to the formation of nitrogen, nitrous oxide, water, and small amounts of hydrogen. The present study was undertaken to obtain confirmatory evidence for the reaction mechanisms discussed in these findings. Nitrogen¹⁵ was used to label the nitrogen atom in the ammonia molecule. It was observed that the exclusive formation of nitrogen molecules of mass 29 and nitrous oxide of mass 44 is predicted by the mechanism.

1874

Rochester U. Dept. of Physics and Astronomy, N. Y.

EFFECTS OF INTRA-CLUSTER GAS AND DUST UPON THE VIRIAL THEOREM, by D. N. Limber. [1959] [33]p. incl. tables. (AFOSR-TN-59-805) (AF 49-638)52 AD 254094 Unclassified

Also published in Astrophys. Jour., v. 130: 414-428, Sept. 1959.

The application of the virial theorem to clusters of galaxies (or stars) is reexamined for the case in which a significant fraction of the total mass of the cluster exists in the form of intra-cluster gas. A modified form for the expression of the virial theorem in this case is obtained in terms of the mean-square velocity of the galaxies, the total mass of the galaxies, the total mass of the gas, the radius of the cluster, a coefficient depending upon the spatial distribution of the galaxies, and a 2nd coefficient depending upon both the spatial distribution of the galaxies and the spatial distribution of the gas—the 2 distributions being different in general. The 2 coefficients are evaluated and tabulated for those cases in which the 2 distributions can be approximated by the polytropic distributions with integral indices. It is shown how the coefficients corresponding to more general distributions can be approximated by means of the tabulated coefficients. (Contractor's abstract)

1875

Rochester U. [Dept. of Physics and Astronomy] N. Y.

K^+ SCATTERING IN THE ENERGY RANGE 100-250

AIR FORCE SCIENTIFIC RESEARCH

MEV, by D. F. Davis, N. Kwak, and M. F. Kaplon. [1959] [4]p. incl. diagrs. tables, refs. (AFOSR-4117) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)303] and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 117: 846-849, Feb. 1, 1960.

Approximately 65 m of K^+ -meson track was scanned in the energy interval 100-250 mev. Analysis of the data shows that the K^+ -neutron charge exchange scattering rises appreciably above the value $1/5$ corresponding to a pure $I = 1$ interaction and at energies > 150 mev appears to be larger than the K^+ -neutron direct scattering. Analysis of the angular distribution of the inelastic events for K^+ incident energies greater than 150 mev indicates a nonisotropic center-of-mass angular distribution, peaked towards $\theta_{c.m.} = 180^\circ$. (Contractor's abstract)

1876

Rochester U. [Dept. of Physics and Astronomy] N. Y.

K^- -MESON ELASTIC SCATTERING BY EMULSION NUCLEI, by D. F. Davis, N. Kwak, and M. F. Kaplon. [1959] [4]p. incl. diagrs. refs. (AFOSR-4118) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)303] and Atomic Energy Commission) Unclassified

Published in Phys. Rev., v. 117: 850-853, Feb. 1, 1960.

Data on elastic nuclear scattering of K^- mesons in emulsion have been obtained. The differential cross section has been calculated by the WKB approximation in the method of partial waves. It is concluded that the real and imaginary potentials necessary to give the correct K^- nucleon cross section also give a good fit to the elastic nuclear scattering data. (Contractor's abstract)

1877

Rochester U. Dept. of Physics and Astronomy, N. Y.

POSSIBLE EVIDENCE FOR A NEGATIVE HEAVY MESON, by T. Yamanouchi and M. F. Kaplon. [1959] [2]p. incl. diagr. (AFOSR-4119) [AF 49(638)303] Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 283-284, Sept. 15, 1959.

Evidence is presented which suggests the existence of a negative heavy meson. It is shown that the new negative meson has a total of 8 prongs, 1 of which is the primary particle initiating the event. It lies in the beam direction, and the grain density measurements at 0.5 mm and 8.5 mm from the star yield the values 2.89 ± 0.12 and 2.58 ± 0.11 times the minimum, respectively, indicating that the particle is indeed moving in the direction of the star. One prong (no. 7) is shown

as a "picture book" Σ^+ hyperon decaying at rest by the protonic mode; it has an energy at emission of 23.2 mev. Another prong (no. 6), in conjunction with no. 7 gives the event its peculiar nature. It appears to come to rest after traversing 628μ and at this point there is associated with it a singly charged particle (δ^+) of 101μ range and a recoil of a few grains. The decay of a He hyperfragment by π^0 mode seems to be compatible with the observations. Assuming that this represents the event, then the lower limit to the total visible prong energy emitted from A is 565 mev. This represents a production of strangeness -2 in a strong interaction.

1878

Rochester U. Dept. of Physics [and Astronomy] N. Y.

STRANGENESS 2 MESON, by T. Yamanouchi. [1959] [3]p. incl. table. (AFOSR-4120) [AF 49(638)303] Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 480-482, Nov. 15, 1959.

Additional support for a previously reported new strange particle (item no. 1877, Vol. III) is presented. It is pointed out that several other investigators have reported events which agree within the limits of experimental error with some of the present findings. According to conventional scheme, a meson of strangeness 2 should occur as an isotopic singlet having $Q = +1$ and $S = +2$; the antiparticle would have $Q = -1$ and $S = -2$. They are called D^+ and D^- respectively. This paper reports on the evidence that suggests the existence of D^- .

879

Rochester U. [Dept. of Physics and Astronomy] N. Y.

K^+ -MESON INTERACTIONS IN NUCLEAR EMULSION (Abstract), by D. F. Davis, M. F. Kaplon, and N. Kwak. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)303] and Atomic Energy Commission) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 25, Jan. 28, 1959.

The study of K^+ -meson interactions in nuclear emulsion has been continued. The "separated" K^+ -meson beam produced at the Berkeley bevatron entered the stack at an energy of 250 mev and was brought to rest in the emulsion. A track length of 77.5 meters has been scanned giving 97 inelastic events. The energy

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dependence of the cross section and of the ratio, charge exchange/inelastic scatter, will be discussed. The elastic scattering in the energy region 100-250 mev will also be presented.

1880

Rochester U. [Dept. of Physics and Astronomy] N. Y.

CORRELATION THEORY OF STATIONARY ELECTROMAGNETIC FIELDS. Part I. THE BASIC FIELD EQUATIONS, by P. Roman and E. Wolf. Oct. 1959, 22p. (Technical note no. 1) (AFOSR-TN-59-1188) (AF 49(638)602) AD 232919; PB 146336

Unclassified

Also published in *Nuovo Cimento*, Series X, v. 17: 462-475, Aug. 16, 1960.

In recent papers a class of 2nd order correlation tensors was introduced and certain differential equations which govern their propagation were postulated. These correlation tensors, which may be regarded as natural generalizations of functions used in the analysis of partially coherent optical wavefields, characterize the correlations which exist between the electromagnetic field vectors at any 2 points in the field, at any 2 instants of time. A derivation of the basic differential equations is presented; and it is shown that the 2 sets into which the equations naturally split are not independent, but in fact follow from each other as a consequence of certain symmetry properties which the correlation tensors exhibit. (Contractor's abstract)

1881

Rochester U. Inst. of Optics, N. Y.

ULTRAVIOLET ABSORPTION IN THALLOUS HALIDES, by S. Tutthasi. July 1959 [13]p. incl. diagrs. refs. (Technical rept. no. 2 under AF 49(638)432 and technical note no. B-4 under AF 49(639)433) AD 225508; PB 143535

Unclassified

Also published in *Jour. Phys. Chem. Solids*, v. 12: 344-348, Feb. 1960.

The ultraviolet absorption in $TlCl$ and $TlBr$ was measured on thin films and fused samples as a function of temperature. The effect of excessive chlorine or thallium on the optical absorption of $TlCl$ was studied. The experiments of Vysochanskii are discussed in the light of the observations obtained here. The 1st absorption band in $TlCl$, which peaks at 3.44 ev at $-185^{\circ}C$, is absent in films condensed on a cold substrate of KCl and appears after annealing. It seems that the crystal structure of evaporated films of $TlCl$ changes from the $NaCl$ -type to the $CsCl$ -type. (Contractor's abstract)

1882

Rochester U. Inst. of Optics, N. Y.

OPTICAL CONSTANTS OF GERMANIUM IN THE REGION 0-10 ev, by M. P. Rimmer and D. L. Dexter. Oct. 1959 [12]p. incl. diagrs. (Technical rept. no. 3) (AFOSR-TN-59-1254) (AF 49(638)432) AD 231204; PB 145646

Unclassified

Also published in *Jour. Appl. Phys.*, v. 31: 775-777, May 1960.

A program was written for the IBM 650 digital computer to evaluate the Kramers-Kronig dispersion relation between real and imaginary parts of the index of refraction, n and k . By this means measurement of the reflection coefficient over a sizable energy range allows the determination of n and k throughout most of this region. Reflection data of Philipp and Taft on Ge were analyzed in this way, and the results are compared with those of Philipp and Taft obtained by another method. The results are similar, minor differences occurring in the fine structure. (Contractor's abstract)

1883

Rochester U. Inst. of Optics, N. Y.

ON THE VARLEY MECHANISM FOR DEFECT FORMATION IN ALKALI HALIDES, by D. L. Dexter. Nov. 1959, 5p. (Technical rept. no. 4) (AFOSR-TN-59-1255) (AF 49(638)432) AD 231205; PB 145645

Unclassified

Also published in *Phys. Rev.*, v. 118: 934-935, May 15, 1960.

Also published in *Proc. Internat'l. Conf. on Color Centers and Crystal Luminescence*, Turin (Italy) (Sept. 8-12, 1960) Turin, Litografia F. Gili, 1961, p. 1-5. (AFOSR-982)

The Varley mechanism is examined, according to which Frenkel defects are produced in the halogen sublattice of alkali halides subsequent to multiple ionization of the halide ions. Arguments are presented to show that the lifetime of a positive halogen ion against recapture of electrons in orders of magnitude smaller than the ejection time of the halogen, and thus that the Varley mechanism is inoperative. The arguments may not be applicable for inner shells alone, but experimental evidence is adduced to eliminate this case.

1884

Rochester U. Inst. of Optics, N. Y.

OPTICAL INVESTIGATION OF SEMICONDUCTORS AT THE UNIVERSITY OF ROCHESTER, by D. L. Dexter. [1959] [9]p. incl. diagrs. refs. (AFOSR-4464) (AF 49-638)432

Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Presented at 1958 Internat'l. Conf. on Semiconductors, Rochester U., N. Y., Aug. 18-22, 1958.

Also published in Jour. Phys. and Chem. Solids, v. 8: 473-481, Jan. 1959.

A survey is given of recent investigations at this institution of optical properties of non-metals. The fundamental absorption of the alkali, silver, and thallous halides and of cadmium sulfide; intrinsic photoconductivity in the alkali halides; electron multiplication in lead sulfide and selenide; and the theory of excitons in the tight binding approximation are among the topics discussed. (Contractor's abstract)

1885

Rochester U. Inst. of Optics, N. Y.

EXCITON STATES IN RARE-GAS CRYSTALS, by R. S. Knox. [1959] [27]p. incl. diagrs. refs. [AF 49(638)432] Unclassified

Published in Jour. Phys. and Chem. Solids, v. 9: 238-264, Mar. 1959.

A formulation of Frenkel's theory of excitons is given in which a general method of constructing orthonormal 1-electron trial exciton functions from atomic functions is outlined, and excitation energies, band structure, effective masses, and integrated absorption cross-sections are computed in an approximation which includes atomic spin-orbit interaction and overlapping of atomic wave functions through terms of the order S^2 . A treatment of singlet and triplet states built from the atomic p^5s configuration in a cubic lattice is given as an example which is intended to apply to the lowest excited states of the rare gases themselves or to corresponding states of halide lattices on a simple excitation model. With the omission of momentum-dependent terms, the formalism is applicable to computations of 1st-order excitation energies in systems involving substitutional impurities. (Contractor's abstract)

1886

Rochester U. Inst. of Optics, N. Y.

EXCITON STATES IN CRYSTALLINE ARGON, by R. S. Knox. [1959] [16]p. incl. diagrs. tables, refs. [AF 49(638)432] Unclassified

Published in Jour. Phys. and Chem. Solids, v. 9: 265-280, Mar. 1959.

The formalism of a previous paper is applied numerically to exciton states in crystalline argon arising from the atomic $3p^54s$ configuration. Under the assumptions that higher configurations do not perturb the energies and transition probabilities and that the Löwdin symmetrical orthogonalization process converges at terms

of order S^2 , the Frenkel model predicts 2 exciton absorption lines at 9 ev (± 1 ev) separated by 0.2 ev and having a combined integrated absorption coefficient of the order of $10^6 \text{ cm}^{-1} \text{ ev}$. The estimated computational error in excitation energy arises not from the neglect of any important interactions but from difficulties in evaluating 2- and 3-center integrals and from the natural inaccuracy of the atomic Hartree-Fock functions. Exciton effective masses are relatively insensitive to the direction of exciton momentum, are of the order +5 electron masses and are found to depend primarily on exchange and overlap interactions rather than the Heller-Marcus long-range interaction. It is suggested that closely related overlap and exchange terms may be of considerable importance in the attractive part of crystal binding energies, particularly in the rare gases. (Contractor's abstract)

1887

Rochester U. Inst. of Optics, N. Y.

PHOTOCONDUCTIVITY IN KI AND RbI, by K. Teegarden. Apr. 10, 1959 [20]p. incl. diagrs. refs. (Technical note no. B3) (AFOSR-TN-59-303) (AF 49(633)433) AD 213087; PB 140537 Unclassified

A threshold for photoconductivity was observed in single crystals of KI at room temperature and RbI at room temperature and 203°K. This threshold occurs at a wavelength somewhat shorter than the position of the first fundamental band in both materials and is presumed to result from band to band transitions. No photocurrent is observed in the region of the first fundamental band in either KI or RbI. (Contractor's abstract)

1888

Rome U. School of Aeronautical Engineering (Italy).

THE EQUIELASTIC MODEL TECHNIQUE IN BLOWN-DOWN WIND-TUNNEL TESTS, by L. Broglio. Dec. 1958 [39]p. incl. diagrs. (Technical note no. 6; SIARgraph no. 46) (AFOSR-TN-59-409) (AF 61(514)888) AD 214506 Unclassified

The importance of building up an equielastic model for solving aeroelastic similarity problems, previously pointed out (see item no. ROM.02:004, Vol. II) is further shown by a general procedure for determining the equielastic model. The 2 main problems of this procedure are: (1) to find the pressure distribution on a solid model, the span wise and chordwise rotations being known at every station; and (2) to determine the tip rotation for a given wing structure. Both problems are here solved in the most general way. Numerical examples complete the work. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

1889

Rome U. School of Aeronautical Engineering (Italy).

EXPERIMENTAL INVESTIGATION ON DELTA WING AND COMPLETE CONFIGURATION MODELS FOR AEROELASTIC SIMILARITY PROBLEMS AT SUPERSONIC BLOW DOWN WIND-TUNNEL, by L. Broglio, C. Buongiorno and others. Mar. 1959 [58]p. incl. illus. diags. tables. (Technical note no. 7; SIARgraph no. 50) (AFOSR-TN-59-954) (AF 61(514)888) AD 226439; PB 144304
Unclassified

The experimental techniques for the aeroelastic investigation at the supersonic blow down wind tunnel are presented. Wind tunnel data at $M = 3.01$ on triangular wing model are given. These results show the small importance of the chordwise deflection of the section on the aerodynamic characteristics. An experimental investigation at $M = 3.12$ on a complete airplane configuration is presented, showing the importance of the

parameter $\frac{P}{E}$ on the lateral stability derivatives.

In the Appendix of the report the preliminary design of a magnetic support for dynamic stability tests is presented. (Contractor's abstract)

1890

Rome U. School of Aeronautical Engineering (Italy).

RESEARCH ON AEROELASTICITY, by L. Broglio. Final rept. May 1959 [12]p. (SIARgraph no. 51) (AFOSR-TR-59-134) (AF 61(514)888) AD 226438; PB 144297
Unclassified

Research is reported on the following: (a) modeling technique and theory for aeroelastic similarity in blow-down wind tunnel tests; (b) developing technique and an experimental device to study the same problems of point (a) but including dynamic effects; (c) finding exact solutions of the problem of the heat conduction in heterogeneous solids with boundary conditions function of space and time.

1891

Rome U. School of Aeronautical Engineering (Italy).

TRANSIENT TEMPERATURES AND THERMAL VIBRATIONS IN SPACE STRUCTURES, by L. Broglio. June 1959 [61]p. incl. diags. (Technical note no. 2; SIARgraph no. 53) (AFOSR-TN-59-1014) (AF 61(052)-198) AD 230271; PB 146708
Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 52-75. (AFOSR-TR-59-108)

The problems of heat conduction analysis and thermal

vibrations were unified and analyzed. The general solution of each of the 2 problems is reached by obtaining Green's function. Application of this method is used for the problems of ablation in heat conducting bodies. Also discussed is the problem of a reentering ablating body of infinitely small conductivity being subjected to kinetic heating.

1892

Rome U. School of Aeronautical Engineering (Italy).

ANISOTROPIC COMPOSITE THERMAL STRUCTURES FOR HYPERSONIC FLIGHT, by L. Broglio. Feb. 1959 [55]p. incl. diags. (Technical note no. 1; SIARgraph no. 52) (AFOSR-TN-59-1015) (AF 61(052)198) AD 230231; PB 146707
Unclassified

The solution is given for the instantaneous source of heat located at a generic point of an anisotropic heterogeneous composite body of whatever shape. The solution satisfies both the differential equation of the heat conduction and the boundary conditions of the specific body. Thus, by using appropriate space integrals of such solution and by leaving all kinds of nonlinearities (such as variation of thermal properties, radiation and so on) to the final timewise integration, a very general solution is found. The solution is introduced for the thermal shock generated by an instantaneous unit timewise temperature step at a generic point of a body of whatever shape. The solution satisfies the differential equations of the dynamic thermal motion and the boundary conditions of the specific body. Here again the most general solution is immediately written as an appropriate space and time integral of the unit solution. By combining the results, the thermal motion generated by an instantaneous heat source located at a generic point is obtained. (Contractor's abstract)

1893

[Royal Coll. of Science and Tech. Dept. of Mathematics, Glasgow (Scotland)].

THE SOLUTION OF BOUNDARY VALUE PROBLEMS FOR A GENERAL HODOGRAPH EQUATION, by A. G. Mackie. Oct. 1958 [16]p. incl. diags. refs. (Technical note no. 5) (AFOSR-TN-59-195) (AF 61(514)-1170) AD 211472
Unclassified

Also published in Proc. Cambridge Philos. Soc., v. 54: 538-553, Oct. 1958.

See item no. RCS.01:006, Vol. II for abstract.

1894

Royal Inst. of Tech., Stockholm (Sweden).

LIQUID FLOW IN TUBES. I. THE TRANSITION PROCESS UNDER HIGHLY DISTURBED ENTRANCE

AIR FORCE SCIENTIFIC RESEARCH

FLOW CONDITIONS, by E. R. Lindgren. [1959] [23]p. incl. illus. diagrs. refs. (AFOSR-TN-59-955) (AF 61-514)1202) AD 226598 Unclassified

Also published in Arkiv Fysik, v. 15: 97-119, Mar. 1959.

Previously reported observations on the transition process in stream bi-refrangent tube flow have been repeated in part. New photographic records are presented in order to improve the illustrative material of previous reports with respect to the characteristics of the transition process. Some of the topics discussed, are as follows: (1) Some effects appearing within laminar flow region; (2) Turbulent spots and turbulent flashes (slugs); (3) Some observations on the decay of eddies; (4) The intermittency factor and the shape of the turbulent flashes; and (5) Turbulent tube flow.

1895

Royal Inst. of Tech., Stockholm (Sweden).

LIQUID FLOW IN TUBES. II. THE TRANSITION PROCESS UNDER LESS DISTURBED INLET FLOW CONDITIONS, by E. R. Lindgren. [1959] [17]p. incl. illus. diagrs. (AFOSR-TN-59-956) (AF 61(514)1202) AD 226599 Unclassified

Also published in Arkiv Fysik, v. 15: 503-519, May 1959.

Previous findings (item no. 1894) are confirmed, according to which transition is caused by primary inlet disturbances of finite strength which cause the initiation of turbulent spots before they fade away and according to which the spots during their downstream travel develop into turbulent slugs. It also is confirmed that the fully developed turbulent slug should be regarded as being composed of a turbulent spot (or spots) traveling along the boundaries and of a central core of eddies with decay maintained by a process of continuous diffusion of eddies from the spot into the core. The "splitting" of turbulent slugs as well as the elongation of turbulent streaks, both of which have been reported previously, are found to be due to the core eddies being brought forward of their generating spots. Some of these always decaying eddies may, before they fade away, initiate the formation of a new spot ahead of the original one. The same process may then repeat itself with the new spots with a probability determined by the flow conditions. The turbulent streaks and possibly also the self-preserving turbulent flow in general appear to be inhomogeneously maintained by discrete turbulent spots. (Contractor's abstract)

1896

Royal Inst. of Tech., Stockholm (Sweden).

LIQUID FLOW IN TUBES. III. CHARACTERISTIC

DATA OF THE TRANSITION PROCESS, by E. R. Lindgren. [1959] [12]p. incl. diagrs. (AFOSR-TN-59-957) (AF 61(052)1202) AD 226597 Unclassified

Also published in Arkiv Fysik, v. 16: 101-112, July 1959.

Qualitative studies on the transition process in tube flow of liquids reported in previous papers of this series were extended to cover also quantitative relationships of this phenomenon for flow of White Hector bentonite sols of various concentrations. Experimental evidence is presented which indicates that the transition process depends on some physical (e.g. structural) properties of the liquids which are not accounted for by the coefficient of viscosity and the density. The findings actually demonstrate that the Reynolds law of similarity does not entirely apply to the flows investigated. These findings are supported also by studies of a new transition quantity, the maximum relative spot velocity (=maximum relative velocity of the rear of the turbulent slugs as defined previously (ROY.02:001, Vol. II), the determination of which is independent of the viscosity of the liquids. (Contractor's abstract)

1897

Royal Inst. of Tech., Stockholm (Sweden).

TRANSITION IN BIREFRINGENT FLUID FLOWS, by E. R. Lindgren. Final rept. Jan. 1, 1957-Mar. 3, 1959. June 23, 1959, 5p. (AFOSR-TR-59-135) (AF 61(514)-1202) AD 242413; PB 150331 Unclassified

The aim of the present study has been to try to remove apparent discrepancies between findings of various authors and if possible to add facts about the transition process which may have escaped previous investigators. Only a general survey of the experimental technique and the findings are presented in this report.

1898

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

ON THE CRYSTAL STRUCTURE OF TELLURIUM (IV) CATHECOLATE, by P. J. Andkainen and G. Lundgren. July 27, 1959 [10]p. incl. diagrs. tables. (Technical note no 1) (AFOSR-TN-59-661) (AF 61(052)162) AD 232076; PB 145621 Unclassified

Also published in Suomen Kemistilehti, v. 32B: 175-179, 1959.

The crystals of $\text{Te}(\text{C}_6\text{H}_4\text{O}_2)_2$ are monoclinic with $a = 22.68 \pm 0.1\text{A}$, $b = 6.93 \pm 0.05\text{A}$, $c = 16.52 \pm 0.1\text{A}$, $\beta = 123.3^\circ \pm 1^\circ$, $V = 2.17 \cdot 10^3 \text{A}^3$. They contain 5 formula units per unit cell giving a calculated density of 210 g/ml. Weissenberg photographs along [010] and [001] show that the reflections hkl are absent when $h + k =$

AIR FORCE SCIENTIFIC RESEARCH

odd and the reflections h0l when h = odd and l = odd. This is characteristic for the space groups no 15 C2/c and no 9 Cc. The tellurium arrangement in the crystals has been determined. It can be described by space group C2/c, where the tellurium atoms are situated in 8(f) with $x = 0.236$, $y = 0.165$, and $z = 0.175$. Work on the determination of the positions of the oxygen and carbon atoms is in progress. (Contractor's abstract)

1899

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

THE HYDROLYSIS OF THE SILVER ION, Ag^+ , IN ACID SELF-MEDIUM, by G. Bledermann and S. Hietanen. [1959] [6]p. incl. table. (Technical note no. 2) (AFOSR-TN-59-662) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)-162 and Swedish Natural Science Research Council) AD 255002 Unclassified

Also published in Acta Chem. Scand., v. 14: 711-716, 1960.

The hydrolysis of the Ag^+ ion has been investigated at 25°C by measuring the hydrogen ion concentration in the self-medium 1 M $\text{Ag}^+(\text{NO}_3^-)$ with a glass electrode.

The data, which indicate an extremely slight hydrolysis at $\log [\text{H}^+] \approx -6.3$, can be explained by the equilibrium

$\text{Ag}^+ + \text{H}_2\text{O} \rightleftharpoons \text{AgOH} + \text{H}^+$ with $\log *K_1 \approx -11.1$; the effect may also be due to polynuclear complexes. No evidence was found for the presence of appreciable amounts of polynuclear hydrolysis products proposed previously. (Contractor's abstract)

1900

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

POTENTIOMETRIC STUDY OF THE ARGENTATE (I) COMPLEX IN ALKALINE SOLUTION, by P. J. Antikainen, S. Hietanen, and L. G. Sillén. July 27, 1959 [16]p. incl. diagrs. table. (Technical note no. 3) (AFOSR-TN-59-663) (AF 61(052)162) AD 232056; PB 145613 Unclassified

Also published in Acta Chem. Scand., v. 14: 95-101, 1960.

The composition of the argentate (I) complex formed in alkaline solutions of silver oxide has been studied by emf titrations with constant ionic medium (0.95 and 12.6 M NaOH, 1.15 and 11.5 M KOH) using $\text{Ag}-\text{AgI}$ electrodes. The data indicate that only mononuclear complexes are formed, from this result, together with the solubility data of other workers, it is concluded that the formula of the complex is $\text{Ag}(\text{OH})_2^-$. No evidence has been found for the presence of the polynu-

clear argentate complexes proposed by some previous workers. The solubility product of $\text{Ag}_2\text{O}(\text{s})$ in 3 M

$\text{Na}(\text{ClO}_4)$ at 25°C was determined as $\log K_{s0} = \log [\text{Ag}^+][\text{OH}^-] = -7.42 \pm 0.02$. (Contractor's abstract)

1901

Royal Inst. of Tech. Dept. of Inorganic Chemistry, Stockholm (Sweden).

APPLICATION OF A LIQUID DISTRIBUTION METHOD TO THE STUDY OF THE HYDROLYSIS OF Ag^+ , by P. J. Antikainen and D. Dyrssen. July 30, 1959 [20]p. incl. diagrs. tables. (Technical note no. 4) (AFOSR-TN-59-644) (AF 61(052)162) AD 232053; PB 145612

Unclassified

Also published in Acta Chem. Scand., v. 14: 86-94, 1960.

The distribution of silver at 25°C between solutions of quinoline (Q) in benzene and 3 M $\text{Na}(\text{ClO}_4, \text{OH})$ has been studied as a function of $[\text{Q}]_{\text{org}}$, $[\text{OH}^-]$ and the silver concentration. In these experiments the reaction

$\text{Ag}^+(\text{aq}) + 2 \text{Q}(\text{org}) + \text{ClO}_4^-(\text{aq}) \rightleftharpoons \text{AgQ}_2\text{ClO}_4(\text{org})$

(eq. const. $\log K = 3.23 \pm 0.02$) was used for the study

of the hydrolysis of Ag^+ in 3 M NaClO_4 at low concentrations of silver. The data provide no evidence for the presence of significant amounts of polynuclear complexes. Furthermore, the data indicate that AgOH is not formed to any large extent in 3 M $\text{Na}(\text{ClO}_4, \text{OH})$.

The value of $\log K_1 K_2 = \log [\text{Ag}(\text{OH})_2^-] [\text{Ag}^+]^{-1} [\text{OH}^-]^{-2}$ was calculated to be 3.50 ± 0.10 in 3 M $\text{Na}(\text{ClO}_4, \text{OH})$.

No evidence was found for $\text{Ag}(\text{OH})_3^{2-}$ in solutions less alkaline than 0.5 M. These conclusions are supported by measurements of the solubility of Ag_2O in 3 M

$\text{Na}(\text{ClO}_4, \text{OH})$. The value of $\log K_{s2} = \log [\text{Ag}(\text{OH})_2^-]$

$[\text{OH}^-]^{-1}$ was determined to be -3.82 ± 0.06 . Together

with the solubility product, $K_{s0} = 10^{-7.42 \pm 0.02}$, deter-

mined by Hietanen (Acta Chem. Scand., v. 13: 1828-

1838, 1959) we obtained $\log K_1 K_2 = 3.60 \pm 0.08$. The

pH of the solubility minimum of Ag_2O is determined by

this constant. In connection with the distribution experiments the distribution constant, K_d , of quinoline

between various organic solvents and 3 M NaClO_4 has been determined. (Contractor's abstract)

1902

Rutgers U. Coll. of Engineering, New Brunswick, N. J.

ANALYSIS OF COMPOSITE X-RAY DIFFRACTION

AIR FORCE SCIENTIFIC RESEARCH

PROFILES, by J. J. Slade, Jr. and L. L. Nanni. June 1960 [8]p. incl. diagrs. refs. (AFOSR-TN-59-1198) (Sponsored jointly by Air Force Office of Scientific Research as technical note no. 1 under AF 49(638)17 and Atomic Energy Commission as technical note no. 3 under AT(30-1)1730) AD 238640 Unclassified

Also published in Jour. Appl. Phys., v. 31: 699-706, Apr. 1960.

The irregular line profiles associated with crystals that have a random structure which is coarse relative to the irradiated area are regarded as the result of the composition of a characteristic distribution and a set of broadening and translating processes. The inversion of this composition is expressed operationally. A differential operator associated with the transform of the intrinsic distribution is introduced. This operator reduces the line profile to the set of broadening and translating elements. The operations are such as may be performed by an analogue computer. Preliminary experiments show that it may be possible to obtain the desired resolution. The effects of "noise" and distortion are investigated. (Contractor's abstract)

1903

Rutgers U. Microwave Electronics Lab., New Brunswick, N. J.

POWER CONVERSION WITH NONLINEAR REACTANCES, by E. Della Torre and M. D. Sirkis. June 1959, 12p. incl. diagr. refs. (Research rept. no. 59-1) (AFOSR-TN-59-596) (AF 49(638)554) AD 217181; PB 143958 Unclassified

Also published in I.R.E. Trans. on Circuit Theory, v. CT-8: 95-99, June 1961.

The Manley-Rowe relationships for a nonlinear reactance are derived proceeding from the voltage-charge characteristic for a capacitance. The method used follows the work of Van der Ziel. The problem is generalized to an arbitrary number of generators. A criterion on the degree of nonlinearity required for power conversion to power at a particular frequency is also derived. A condition on the oscillator frequencies is found, but this condition proves to be less strict in

any practical case than the Manley-Rowe requirement of incommensurability. Output filter considerations are also discussed. (Contractor's abstract)

1904

Rutgers U. School of Chemistry, New Brunswick, N. J.

SENSITIZATION OF MERCURIOUS OXALATE BY DYES, by P. A. van der Meulen and R. H. Brill. [1959] [7]p. incl. diagrs. tables. (AFOSR-TN-59-451) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)1150 and Squier Signal Lab., Fort Monmouth, N. J. under DA 36-039-sc-1666) AD 264119

Unclassified

Also published in Photog. Sci. and Eng., v. 2: 121-127, Oct. 1958.

See item no. RUT.05:001, Vol. II for abstract.

1905

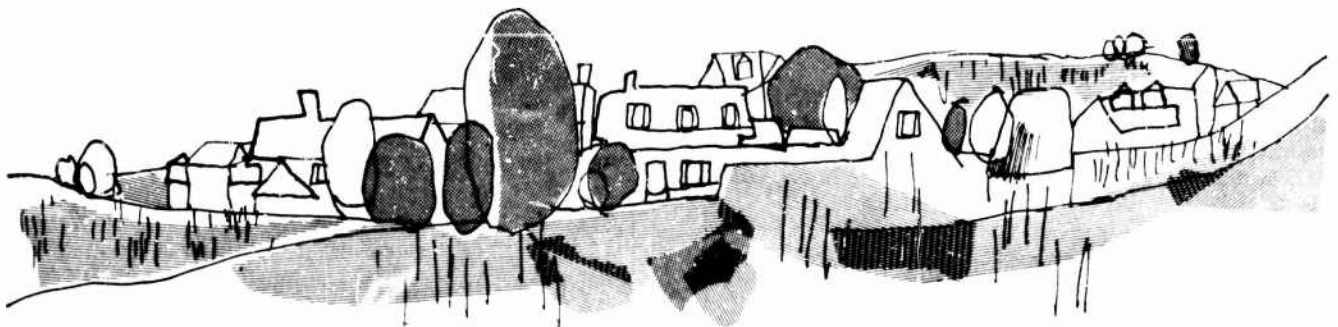
Rutgers U. School of Chemistry, New Brunswick, N. J.

PHOTOTHERMOGRAPHIC SENSITIZATION OF MERCURIOUS OXALATE BY MERCURIOUS AND SILVER IODIDES, by P. B. Gilman, Jr., P. A. Vaughan, and P. A. van der Meulen. [1959] [21]p. incl. diagrs. table, refs. (AFOSR-TR-59-67) (AF 18(600)1150) AD 217410

Unclassified

Also published in Photog. Sci. and Eng., v. 3: 21-220, Sept.-Oct. 1959.

Gelatin emulsions containing mercurous oxalate and mercurous iodide have photothermographic sensitivity to visible light. Sensitometric studies show that the sensitization of mercurous oxalate by mercurous iodide is increased considerably by the addition of silver iodide, although the latter compound by itself is not a sensitizer. Sensitometric and x-ray diffraction studies indicate that the sensitization is caused by the photolysis of mercurous iodide to form mercury and mercuric iodide. In the absence of silver iodide, yellow mercuric iodide is a product of photolysis. If silver iodide is present, red mercuric iodide and/or Ag_2HgI_4 are formed and the efficiency of the photolysis of mercurous iodide is increased. (Contractor's abstract)



AIR FORCE SCIENTIFIC RESEARCH

1906

St. Louis U. [Dept. of Physics] Mo.

THE BETHE-SALPETER EQUATION AND THE HYDROGENLIKE ATOM, by Z. V. Chraplyvy and E. M. MacKinnon. Final technical rept. Oct. 15, 1959, 24p. (AFOSR-TR-59-155) (AF 18(600)789) AD 229677

Unclassified

The Drelt Hamiltonian for a 2-particle system consists of 2 Dirac Hamiltonians plus interaction terms. The Bethe-Salpeter (B.S.) Hamiltonian does not have such a simple relation to the Dirac Hamiltonian except in the case of uncoupled particles. A requirement which the B.S. equation should fulfill is the ability to reproduce the established results of the Dirac equation to the extent they agree with the experiment. To test this point, the B.S. equation for the hydrogenlike atom is converted to an equivalent 1-particle equation, comparable to the Dirac equation. Its eigenfunctions and eigenvalues are determined in 2 steps. The equation is simplified further and the exact solutions of the simplified version are found in closed form. They serve as an approximation to the solutions of the full 1-particle equation using the Fock transformation and the Fock-Hecke theorem.

1907

St. Louis U. [Dept. of Physics] Mo.

SOLUTION OF A REDUCED BETHE-SALPETER EQUATION (Abstract), by E. M. MacKinnon and Z. V. Chraplyvy. [1959] [1]p. [AF 18(600)789]

Unclassified

Presented at meeting of the Amer. Phys. Soc., Cambridge, Mass., Mar. 30-Apr. 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 156, Mar. 30, 1959.

One test of the validity of the Bethe-Salpeter (B.S.) equation and especially of the ladder approximation is its capability of reproducing the Dirac results for the H atom. This is examined theoretically by using Salpeter's 3-dimensional form of the B.S. equation and reducing it to an equivalent 1 body form similar to the Dirac equation. This is solved in momentum space by the Fock-Iévy method. The reduced B.S. equation reproduces the Dirac eigenvalues to the order of accuracy of the fine-structure splitting (order α^4). The principal (order 1 and α) terms in the eigenfunctions are reproduced but not the higher coefficients (of order α^2 and α^3).

1908

St. Louis U. Dept. of Physics, Mo.

PART I. CRITICAL ANALYSIS AND APPLICATIONS

OF A QUASI-RESONANT THEORY OF PRESSURE BROADENING OF LINEAR MOLECULES. PART II. COLLISION BROADENING IN THE MICROWAVE SPECTRA OF SYMMETRIC TOP MOLECULES, by L. J. Kieffer, J. G. Broerman, and A. V. Bushkovitch. Final technical rept. May 1, 1959, 1v. incl. diagrs. tables, refs. (AFOSR-TR-59-29) (AF 18(600)1590) AD 212702; PB 142160

Unclassified

Part I also published in Jour. Molec. Spectrosc., v. 2: 558-565, Dec. 1958.

Part I. See item no. STL02:004, Vol. II, for abstract. Part II. The collision cross sections for dipole-dipole, dipole-quadrupole, and quadrupole-quadrupole interactions were calculated in this paper. Unfortunately, line breadth data for non-inversion symmetric top spectra are insufficient for comparison with experiment.

1909

St. Louis U. [Dept. of Physics] Mo.

SOME APPLICATIONS OF RELATIVISTIC WAVE EQUATIONS TO SOLID STATE PROBLEMS. I, by W. A. Barker, R. Pendergast, and M. Lal Narchal. [1959] 14p. incl. refs. (AFOSR-TN-59-1259) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)612 and National Science Foundation)

Unclassified

In solid state physics the spin and the magnetic moment of the electron play important roles. However a relativistic formulation of solid state problems is not common. The Dirac equation for an electron in an electromagnetic environment which may include the local effects of the solid as well as externally applied fields is rewritten in an approximately relativistic formulation, using the Foldy-Wouthuysen method. Both spin dependent and spin independent terms are discussed in connection with hydrogen like problems and electron spin resonance. (Contractor's abstract)

1910

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

SIDEREAL ANISOTROPY OF HIGH ENERGY COSMIC RAYS, by I. Escobar V., N. Nerurkar, and R. Well. [1959] [6]p. incl. diagrs. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)290], Atomic Energy Commission, and Office of Naval Research)

Unclassified

Published in Planetary and Space Sci., v. 1: 155-160, Aug. 1959.

Abstract published in Proc. Internat'l. Conf. on Cosmic Rays, Moscow (USSR) (July 6-11, 1959), Moscow, v. 4: 273-274, 1960.

AIR FORCE SCIENTIFIC RESEARCH

The experiment, detecting extensive air showers responding to primary energies greater than 10^{14} ev and being carried out at Chacaltaya, Bolivia (elevation of 5220 m; geographic latitude of 16° S), is described. The counter trays were separated by at least 20 m. The results (over a period of 230 days) indicated that there was evidence of a sidereal anisotropy of about 1.6% with the time maximum at 1400 LST (local sidereal time). The barometric coefficient was discussed in connection with the absorption curve for extensive showers. It showed that the pressure correction had no effect on the obtained anisotropy. (Contractor's abstract, modified)

1911

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[INTERNATIONAL CONFERENCE OF COSMIC RAYS] Conferencia Internacional de Radiacion Cosmica, by I. Escobar V. [1959] [8]p. [AF 49(638)290]

Unclassified

Also published in Rev. Mex. Fis., v. 8: 273-280, Oct. 1959.

The conference on cosmic rays, sponsored by the International Union of Pure and Applied Physics over 2 yr, was held from July 6th to 11th, 1959 at the University of Moscow. It was attended by many people. The new president of the conference was D. S. Skobel'tyn. The highlights of the conference are given.

1912

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[THE DENSITY SPECTRUM OF AIR SHOWERS AT 4100 m] Espectro de densidad de chubascos a 4,100 m, by J. Hersil. [1959] [8]p. incl. diagrs. (AF 49(638)290)

Unclassified

Published in Resumen de Labores, 1959, La Paz (Bolivia), Laboratorio de Fisica Cosmica, Dec. 1959, p. 34-38.

The density spectrum of air showers at this altitude was determined by means of a plastic scintillation detector, G-M counters, and a cathode ray oscilloscope. Based on the histogram taken without an absorber, a straight line was obtained by connecting the mean arithmetic densities for each interval. Using the same method, spectra obtained under different conditions with respect to the absorber were analyzed. Some measurements were also made to see if the density spectrum showed any energy dependence at this altitude. Results

seem to indicate that the spectrum coincides perfectly with that obtained without absorbing material, except for density values less than 70/sq m. (Contractor's abstract, modified)

1913

San Andres U. Laboratorio de Fisica Cosmica de Chacaltaya, La Paz (Bolivia).

[PRELIMINARY RESULTS ON THE DEGREE OF DEVELOPMENT OF THE EXTENSIVE AIR SHOWERS OF HIGH ENERGY AT 4100 m] Resultados preliminares sobre el grado de desarrollo de los chubascos extensos de alta energia a 4,100 m, by J. Hersil and R. H. Schulcezwski. [1959] [7]p. incl. diagrs. (AF 49(638)-290)

Unclassified

Published in Resumen de Labores, 1959, La Paz (Bolivia), Laboratorio de Fisica Cosmica, Dec. 1959, p. 39-43.

The status of the work on extensive air showers being carried out at El Alto is described. The influence of temperature on detector sensitivity is analyzed in some detail. The preliminary results are given on the lateral distribution of showers at this altitude. A zenith angle distribution for showers in a relatively broad size range is worked out without the aid of a computer. Conclusions, however, should not be drawn until a more complete analysis is made on larger samples that are now in process at MIT computing center. The data handling system used at La Paz in order to reduce reaction errors to a minimum is also described. (Contractor's abstract)

Sarah Mellon Scaife Radiation Lab., Pittsburgh, Pa. see Pittsburgh U. Sarah Mellon Scaife Radiation Lab., Pa.

Sibley School of Mechanical Engineering, Ithaca, N. Y. see Cornell U. Sibley School of Mechanical Engineering, Ithaca, N. Y.

Sloane Physics Lab., New Haven, Conn. see Yale U. Sloane Physics Lab., New Haven, Conn.

1914

Smith Coll. Dept. of Chemistry, Northampton, Mass.

A THEORETICAL STUDY OF THE RELATIONSHIP BETWEEN THE PROPERTIES OF A SOLID AND CHARACTERISTICS OF ITS CONSTITUENT PARTICLES, by G. S. Durham, B. A. Soderberg, and E. B. Rothman. Final rept. Apr. 1959, 13p. incl. diagrs. tables, refs. (AFOSR-TR-59-55) (AF 18(600,775) AD 216254)

Unclassified

A brief summary of the work reported in a previous

AIR FORCE SCIENTIFIC RESEARCH

paper (SML01: 002, Vol. II) is presented. The calculations used to arrive at the lattice sum or any higher interaction sum are shown. The conclusions reached from a study of the surface-structure calculations for outer 1 + 0 + 0 planes of NaCl, KCl, and KBr are discussed. It is shown that consideration of van der Waals forces can make as much as 0.05 r_0 difference in the displacement of the ions; also cation polarization makes very little difference in the case of NaCl, but is appreciable for KCl and KBr. The work concerned with the free energies of mixing of NaCl-NaBr solid solutions at 35° is reported on also. The results presented in table form show the free energy curve is such as to predict partial immiscibility in the system. A discussion is also given on the determination of the heat of mixing of a KCl-KBr solid solution prepared at 25°.

These are done as an experimental check on the calculations of the energy of local order in an equimolar KCl-KBr solid solution. The last section discusses the equation for the cohesive energy of a metallic crystal as a function of distance of particle separation.

1915

South Carolina U. Dept. of Electrical Engineering, Columbia.

APPLICATIONS OF DIELECTRIC PRISMS AT MILLIMETER WAVELENGTHS, by R. G. Fellers. July 16, 1959 [21]p. incl. illus. diagrs. refs. (AFOSR-TN-59-637) (AF 18(603)43) AD 219785 Unclassified

This paper describes the use of a pair of dielectric prisms as an adjustable bidirectional coupler and as a cut-off attenuator capable of theoretical calibration. Such devices may be used as a part of a free-space transmission system intended to replace waveguide for transmission of energy over within-system distances. It is expected that transmission of this type will find its max usefulness in the mm wavelength range. (Contractor's abstract)

1916

Southern California U. Dept. of Chemistry, Los Angeles.

THE REACTION OF (+)-ENDO-NORBORNYLAMINE WITH NITROUS ACID, by J. A. Berson and D. A. Ben-Efraim. [1959] 20p. incl. diagrs. refs. (AFOSR-TN-59-23) (AF 18(600)1544) AD 208753 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 4094-4099, Aug. 5, 1959.

(-)-endo-Norbornanecarboxylic acid, 34-35% optically pure, reacts with hydrazoic acid to give (+)-endo-norbornylamine of the same optical purity. In acetic acid, the (+)-amine reacts with sodium nitrite to give exo-norbornylacetate with 23-24% retention of optical purity. The enantiomeric configurations of the amine

and product acetate are related on the basis of the stereochemical result and known data on isotope-position rearrangement in this reaction. The optical result is virtually identical with the % retention of skeletal integrity observed in the nitrous acid deamination of endo-

2-amino-5-norbornene-3-¹⁴C. The correspondence suggests that the excess unrearranged portion of the product acetate from both amines is derived by direct displacement of solvent on the diazonium ion. (Contractor's abstract)

1917

Southern California U. Dept. of Chemistry, Los Angeles.

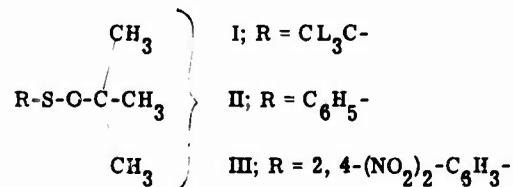
DERIVATIVES OF SULFENIC ACIDS. XXXVII. STUDIES OF SULFENYL ESTERS (THIOPEROXIDES). PART 5. THERMAL DECOMPOSITIONS, by R. S. Irwin and N. Kharasch. [1959] 11p. incl. diagrs. refs. (AFOSR-TN-59-847) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)330] and Office of Ordnance Research) Unclassified

Presented at meeting of the Org. Chem. Div. of the Amer. Chem. Soc., Atlantic City, N. J., Sept. 13-18, 1959.

Abstract published in 136th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1959, p. 39-p. (Title varies)

Also published in Jour. Amer. Chem. Soc., v. 82: 2502-2505, May 20, 1960.

The pyrolysis of selected t-butyl esters of sulfenic acids was studied.



Compounds II and III yield isobutylene as the major volatile product, whereas I yields up to 90% t-butyl chloride. No acetone was found in any case, showing that t-butoxy radicals are not involved, as might be expected by comparisons with peroxide pyrolyses. Other evidence suggests that the pyrolyses of I, II and III, under the conditions studied, do not involve homolysis of the -S-O-bond. A mechanism, which involves a cyclic transition state, analogous to that proposed for the pyrolysis of alkyl xanthates, is proposed. (Contractor's abstract)

1918

Southern California U. Dept. of Chemistry, Los Angeles.

DERIVATIVES OF SULFENIC ACIDS. XXXIII.

AIR FORCE SCIENTIFIC RESEARCH

2,4-DINITROPHENYL SELENIUM TRICHLORIDE, by D. D. Lawson and N. Kharasch. [1959] 3p. incl. diagrs. refs. (AF 49(638)230) **Unclassified**

Published in Jour. Org. Chem., v. 24: 857-859, June 1959.

The original purpose of the research was to prepare 2,4-dinitrobenzeneselenenyl chloride (II). In the course of the work, however, a superior method for cleaving bis(2,4-dinitrophenyl) disulfide was devised, involving the use of sulfuryl chloride and pyridine. This procedure was successful in the chlorinolysis of the corresponding diselenide, but the product was not the selenenyl chloride (II), but the trichloride (I). Further study established that the trichloride is in equilibrium with the monochloride $\text{ArSeCl}_3 \rightleftharpoons \text{ArSeCl} + \text{Cl}_2$ (Ar = 2,4-dinitrophenyl), but that I can be prepared by using excess sulfuryl chloride in the chlorinolysis of the selenocyanate or bis(2,4-dinitrophenyl) diselenide. It is pointed out that the trichloride is an excellently crystalline solid and can be stored for long periods of time without change. The results suggest that the readily prepared trichloride may be used as the in situ precursor for reactions requiring the selenenyl chloride.

1919

Southern California U. Engineering Center, Los Angeles.

A NOTE ON THE THERMAL CONDUCTIVITY OF SOLID NITROGEN AND THE DIRECT CONDENSATION OF NITROGEN GAS INTO A SOLID, by K. Karamcheti. Jan. 31, 1959, 13p. incl. diagrs. (USCEC rept. no. 56-206) (AFOSR-TN-59-183) (AF 18(603)95) AD 211323; PB 140225 **Unclassified**

In a low density tunnel designed to operate on the "2-phase" principle, nitrogen gas is used as the working medium. Downstream of the test section, the gas is condensed directly into a solid by exposing the gas to a refrigerated surface maintained at a constant temperature (in the range of 15 to 30°K). To estimate the condensation rate/unit area of surface, the problem is treated from the point of view of 1-dimensional unsteady heat conduction through the growing layer of the solid condensate. An analytical solution of the problem is obtained. It is seen that the condensation rate can be evaluated once the density, the specific heat, the latent heat of sublimation, and the thermal conductivity, k , of solid nitrogen are known. While the other quantities are known, k is not known. The analysis is, therefore, used in conjunction with some test data, where the growth with time of the condensate thickness is measured, to obtain an estimate for k . This turns out to be 2.455×10^{-4} cal/sec cm °K. Using this value of k , relations are given for the condensate thickness and the condensation rate at any time. (Contractor's abstract)

1920

Southern California U. Engineering Center, Los Angeles.

SOME PROBLEMS IN HYDROMAGNETICS, by K. P. Chopra. Jan. 31, 1959, 210p. incl. diagrs. tables, refs. (USCEC rept. no. 56-205) (AFOSR-TN-59-265) (AF 18(603)95) AD 212468; PB 142687 **Unclassified**

The following topics are discussed: (1) Induction drag of a sphere moving in a conducting fluid in the presence of a magnetic field; (2) Hydromagnetic flow in a circular pipe; (3) Magnetic fields in a conducting fluid sphere and infinite cylinder with electric currents flowing in them; (4) Change in energy of a magnetic sphere under a P_1 -deformation (equilibrium configurations of the sphere); (5) Radial adiabatic pulsations of an infinite cylinder in the presence of a magnetic field; (6) Tunnel effect in hydromagnetics; (7) Compressible hydromagnetics; (8) Thermodynamics of compressible hydromagnetic flow; (9) Hydromagnetic shock waves; (10) Diffusion and plane hydromagnetic shock waves; (11) Drag of a sphere in an ionized gas; and (12) Transmission properties of Alfvén waves.

1921

Southern California U. Engineering Center, Los Angeles.

PRODUCTION OF CARBON IN THE UPPER ATMOSPHERE, by K. P. Chopra. July 31, 1959, 8p. incl. refs. (USCEC rept. no. 56-208) (AFOSR-TN-59-902) (AF 18(603)95) AD 228197; PB 144474 **Unclassified**

This technical note describes a process by which penetrating cosmic rays may produce atomic carbon in the upper atmosphere. High energy cosmic ray particles bombard the atoms and molecules of the upper atmosphere and release neutrons along with other products of disintegration. Some of these neutrons escape outwards and undergo a natural free decay. Some others may collide with nitrogen atoms and produce atomic carbon with the release of a proton. These carbon atoms are radioactive and decay back into atomic nitrogen with the release of a high energy electron. But the fairly long lifetime (5569 years) ensures a copious supply of carbon atoms in the upper atmosphere. The other products of this process, viz. protons and electrons, may get trapped in the earth's magnetic field, and hence contribute to the formation of the inner radiation belt. (Contractor's abstract)

1922

Southern California U. Engineering Center, Los Angeles.

SOME FURTHER RESULTS ON HEATING A SUPERSONIC GAS STREAM WITH A RADIO FREQUENCY DISCHARGE, by F. O. Smetana. Nov. 1, 1959, 16p. incl. illus. diagrs. (USCEC rept. no. 56-207) (AFOSR-TN-59-1127) (AF 18(603)95) AD 229491; PB 144781 **Unclassified**

AIR FORCE SCIENTIFIC RESEARCH

Results of further experiments with RF discharge heating of a supersonic gas stream are reported. Temperature increases of at least 600°F were recorded although the presence of strong electrical fields made it extremely difficult to interpret temperature indications. The action of the ionized gas and the strong field limits the type of materials which may be used for nozzle materials. Qualitative indications of the decay of active species, N-N recombination, wall heating, effect of pressure, nozzle configuration, and electrode configuration were also obtained. (Contractor's abstract)

1923

Southern California U. Engineering Center, Los Angeles.

DIFFUSION OF A FULLY IONIZED GAS CONFINED IN A STRONG MAGNETIC FIELD, by T. Koga. Dec. 30, 1959, 33p. incl. diagrs. table, refs. (USCEC rept. no. 56-209) (AFOSR-TN-59-1132) (AF 18(603)95) AD 231047; PB 145638 Unclassified

Presented at meeting of the Amer. Phys. Soc., Ann Arbor, Mich., Nov. 23-25, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 5: 127, Mar. 4, 1960.

The transport phenomena is studied of a fully ionized gas in the presence of a strong magnetic field. It is shown that there is a certain domain in the density-temperature space where the Boltzmann equation is valid. The mean free path is assumed to be longer than the mean Larmor radius. An average of the Boltzmann equation is made along a circular trajectory of gyrating particles. By this method of coarse-graining, the Boltzmann equation is reduced to the equation of diffusion. It is not assumed that the distribution function is close to the Maxwell function. A special case of constant energy per particle is treated in detail. No specific assumption of the distribution function is made. The effect of the collisions between similar particles is negligible, and the ions and electrons diffuse almost at the same velocity. It is easily possible to apply the method to more general cases. (Contractor's abstract)

1924

Southern California U. [Engineering Center] Los Angeles.

ON THE SECOND APPROXIMATION TO THE STRESS AND THE HEAT FLUX IN A GAS (Abstract), by H.-T. Yang. [1958] [1]p [AF 18(603)95] Unclassified

Presented at meeting of the Amer. Phys. Soc., San Diego, Calif., Nov. 24-26, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 169, Mar. 30, 1959.

The classical expressions for the 2nd approximation

to the stress and the heat flux in a gas are those of Burnett. More recent work in the kinetic theory of gases consists of Grad's 13th-moment equations and Ikenberry-Truesdell's iterates. The Burnett equations may be deduced from the latter 2 systems, which are, therefore, more general. All these 3 approaches are approximating the Boltzmann equation by partial differential equations for the flow variables. Another way is to approximate the Boltzmann equation directly by replacing the collision integral by a simple collision term. This results in the simplified partial differential equation of Bhatnagar, Gross, and Krook for the molecular distribution function. The 2nd approximation to the stress based on this simplified collision equation is obtained by Burgers and that to the heat flux is obtained here. It is shown that these 2nd approximations based on the simplified collision equation are compared favorably with those based on the full Boltzmann equation.

1925

Southern California U. Engineering Center, Los Angeles.

EXPERIMENTS ON A RADIO FREQUENCY DISCHARGE PLASMA IN SUPERSONIC FLOW, by R. L. Chuan and F. O. Smetana. [1959] [8]p. incl. illus. diagr. table. [AF 18(603)95] Unclassified

Published in Proc. 1959 Heat Transfer and Fluid Mech. Inst., California U., Los Angeles (June 11-13, 1959), Stanford, Stanford U. Press, 1959, p. 236-243.

The little-studied problems associated with the heating technique used when developing a radio frequency discharge for use as a heat source in low density, supersonic flow are discussed. These problems include that of providing a suitable electrode configuration which permits matching of the generator to the load and which provides for minimum stray radiation and high density power input. Also studied was the problem of determining an optimum length of time or distance during which the recombination processes would be sufficiently near completion and for which the physical length would not be unreasonable or the heat transfer to the walls self-defeating. As a means for permitting the decay processes to reach equilibrium, control of diffusion of free electrons with its subsequent heat transfer to the wall was also discussed. The results and some preliminary interpretations of their significance are given. (Contractor's abstract, modified)

1926

Southern California U. [Engineering Center] Los Angeles.

DRAW OF AN ARTIFICIAL EARTH SATELLITE (Abstract), by R. L. Chuan and K. P. Chopra. [1959] [1]p. [AF 18(603)95] Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

AIR FORCE SCIENTIFIC RESEARCH

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 360, Aug. 27, 1959.

Recently the problem of drag on an artificial satellite has been taxing the curiosity of several authors. This paper discusses several physical processes which may contribute to the drag of an artificial satellite (or for that matter, any body) moving in an ionized atmosphere with a pervading magnetic field. These processes involve electromagnetic induction (induction drag), Coulomb scattering of charged particles (Coulomb drag), ionization caused by the satellite (ionization drag), the emission of plasma waves (wave drag), surface interactions with impinging particles (surface drag), etc., besides the direct collisions (neutral aerodynamic drag). An insight can be obtained by performing simple experiments in a low-density wind tunnel under specified conditions.

1927

Southern California U. [Engineering Center] Los Angeles.

PROPAGATION OF A PLANE NORMAL SHOCK WAVE IN A GAS MIXTURE OF TWO KINDS OF CHARGED PARTICLES IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD (Abstract), by I. Singh and K. P. Chopra. [1959] [1]p. [AF 18(603)95] Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 363, Aug. 27, 1959.

The propagation of a shock wave in a gas mixture sets up diffusion and causes a change in the composition of the fluid. The effect of diffusion on the propagation properties of a shock wave in the presence of a transverse magnetic field forms the subject matter of this paper. Transverse (induced by magnetic field) and thermal diffusions have been ignored for simplicity. Expressions for the composition parameter, and pressure, density, and velocity ratios are obtained. Chief conclusion is that the presence of a transverse magnetic field narrows down the range of values for the density ratio. The analysis is suggestive of the contribution of diffusion to the structure of the shock front. However, this conclusion is not established to finality.

1928

Southern California U. [Engineering Center] Los Angeles.

THERMODYNAMIC PROPERTIES OF FLUID FLOW ACROSS MAGNETIC FIELD. I. (Abstract), by K. P. Chopra. [1959] [1]p. [AF 18(603)95] Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 363, Aug. 27, 1959.

This paper deals with the study of various thermodynamic quantities like internal energy, enthalpy, entropy, etc., involved in the investigation of the flow of a conducting fluid in the presence of a uniform transverse magnetic field. The analogs of Rayleigh and Fanno lines readily follow from the basic equations. It is shown that in the presence of a transverse magnetic field, the internal energy and enthalpy of an electrically conducting fluid, obeying perfect gas equation, depend (unlike in ordinary fluid-flow thermodynamics) on its density and the strength of the magnetic field. The entropy and the specific heat at constant volume do not seem to be affected by the presence of the magnetic field. The behavior of specific heat at constant pressure depends on which of the gas and the total pressure is kept constant. A transverse magnetic field reduces the specific heat at constant gas pressure and the corresponding adiabatic constant by a factor proportional to the ratio of the magnetic pressure to the gas pressure. However, if the total (gas plus magnetic) pressure is kept constant, the magnetic field has no effect. Lastly, the effect of the magnetic field on velocity of sound and the Mach number is discussed. In the limiting cases of weak and strong magnetic fields, the velocity of sound reduces to the ordinary sonic speed and the Alfvén speed respectively.

1929

Southern California U. [Engineering Center] Los Angeles.

THERMODYNAMIC PROPERTIES OF FLUID FLOW ACROSS A MAGNETIC FIELD. II. (Abstract), by K. P. Chopra and I. Singh. [1959] [1]p. [AF 18(603)95] Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 376, Aug. 27, 1959.

This paper is devoted to the study of the effects of a transverse magnetic field on some of the flow characteristics of a perfectly conducting fluid. It is seen that the effect of an area change (as in a nozzle) on the subsonic or supersonic flow is not affected by the presence of the magnetic field. However, it is demonstrated that the presence of a transverse magnetic field is conducive to the formation of a shock wave. The analog of Prandtl's equation is derived and the expression for the critical speed is obtained. It follows that the flow is definitely subsonic if the stream velocity is less than or equal to the critical speed. On the contrary, if the stream velocity exceeds the critical speed, the hydromagnetic flow may be supersonic, sonic or subsonic. Use of the jump conditions leads to the analog of Prandtl's relation for shock waves. The expressions for jumps in internal energy and enthalpy across the shock front readily follow. New Hugoniot function is defined and the surface

AIR FORCE SCIENTIFIC RESEARCH

represented by the Hugoniot equation in the (τ, p^*, H) space is a hyperbolic paraboloid. As in ordinary shock waves, the entropy change across the shock-front is of the 3rd order in specific volume.

1930

Southern California U. [Engineering Center] Los Angeles.

INTEGRATED FORM OF THE BOLTZMANN EQUATION AND ITS APPLICATION TO GAS DYNAMICS, by T. Koga. [1959] [3]p. (AF 18(603)95) Unclassified

Published in Phys. Fluids, v. 2: 580-582, Sept.-Oct. 1959.

In this note the Boltzmann equation is analyzed and an integration derived which may be used directly for obtaining macroscopic variables as functions of space and time variables, satisfying given boundary conditions.

Here the Boltzmann equation is treated as $\frac{\partial f}{\partial t} + c \frac{\partial f}{\partial r} + F \frac{\partial f}{\partial c} - \left(\frac{\partial f}{\partial t} \right)_{\text{coll}} = 0$. This method of approach permits fairly simple relations to be obtained to which the distribution function is subject in cases where a gas field is known to have a certain uniformity. It can also be applied to magnetohydrodynamics of gases.

1931

Southern California U. Engineering Center, Los Angeles.

THE COMPRESSIBLE LAMINAR BOUNDARY LAYER WITH ARBITRARY PRESSURE GRADIENT AND WALL TEMPERATURE DISTRIBUTION, by J. C. Williams, III. [1959] [2]p. (AF 18(603)95) Unclassified

Published in Jour. Aero/Space Sci., v. 26: 677-678, Oct. 1959.

A method is presented for removing the restriction of similar solutions and thereby obtaining solutions to the compressible laminar boundary layer with arbitrary pressure gradient and wall temperature distributions. It is necessary to assume the following conditions: (a) constant specific heat, (b) Prandtl Number of unity, and (c) a viscosity-temperature relationship $\mu = \mu_0 \lambda T/T_0$, and by employing the Stewartson type of transformation the compressible laminar boundary layer equations can be transformed into the set (1) $(\partial U/\partial X) + (\partial V/\partial Y) = 0$, (2) $U(\partial U/\partial X) + V(\partial U/\partial Y) = U_E(dU_E/dX)(1 + S) + \nu_0(\partial^2 U/\partial Y^2)$ and (3) $U(\partial S/\partial X) + V(\partial S/\partial Y) = \nu_0(\partial^2 S/\partial Y^2)$. Thus (4) $dX = \lambda(a_e/a_0)(p_e/p_0)dx$, $dY = (p/p_0)(a_e/a_0)dy$, $U = (\partial \psi/\partial X) = (a_0/a_e)u$, $V = \partial \psi/\partial Y$ and any solution of the transformed set of equations (1-3) is a solution of a physical-boundary-layer problem and is related to the physical problem through equation 4. The equation 1-3 are solved by a series solution type of analysis.

1932

Stanford Research Inst., Menlo Park, Calif.

FLUX DISTRIBUTION NEAR THE FOCAL POINT, by R. E. de la Rue, Jr., E. Loh and others. [1957] [5]p. incl. diagrs. (AFOSR-3505) (AF 18(600)1499)

Unclassified

Also published in Jour. Solar Energy Sci. and Eng., v. 1: 84-98, Apr.-July 1957.

It is shown that off-focus operation can be used to control flux and thus the temperature of a target, instead of the various possible mechanical methods. Although the size of the area of uniform flux decreases as the plane of interest moves away from the focal plane, it again increases in size and uniformity at a distance of over 2 sun images from the focal plane. Also, the average flux received by the central uniform region of an off-focus plane cannot be determined by the inverse area law. It is also shown that to obtain the maximum flux delivered by a parabolic solar furnace, the target must be positioned properly. To obtain temperatures within 5% of the maximum attainable temperatures, a target must be placed within a distance of one-half of a sun image unit from the focal plane.

1933

Stanford Research Inst., Menlo Park, Calif.

THE SOLAR FURNACE. NEW TOOL FOR HIGH-TEMPERATURE WORK, by G. Benveniste and N. K. Hiester. [1956] [6]p. incl. illus. diagrs. tables, refs. (AFOSR-3666) [AF 18(600)1499] Unclassified

Presented at meeting of the Amer. Soc. Mech. Engineers, Denver Colo., Sept. 10-12, 1956.

Also published in Mech. Eng., v. 78: 915-920, Oct. 1956.

The application of the solar furnace to high temperature research and industrial programs is discussed. The discussion includes the basic principles and characteristics of furnaces in operation, descriptions of the units now being utilized or being planned throughout the country, and the historical background of solar furnaces. These units are useful tools for high-temperature work up to 3000-3500°C. They can be used in experiments where lack of contamination from flames, combustion products, electrodes and refractory fragments is important.

1934

Stanford Research Inst., Menlo Park, Calif.

NEW ELECTRON ACCEPTORS FOR THE HILL

AIR FORCE SCIENTIFIC RESEARCH

REACTION II. CHROMIC ION, by R. J. Marcus. Dec. 1, 1959, 7p. incl. diagrs. (Technical note no. 3; rept. no. 14) (AFOSR-TN-59-1321) (AF 18(603)7) AD 231929; PB 145671 Unclassified

A new electron acceptor for the Hill reaction, chromic ion, has been found on the basis of previous work on the absorption spectra of Hill reaction oxidants. Because of its low solubility at physiological pH, this oxidant must be used in conjunction with a secondary oxidant (MnO_2), an excess of which will maintain a constant, but small, concentration of chromic ion by immediate reoxidation of the reduction product. No reoxidation appears to take place in the absence of MnO_2 , either by reduction of water or by ultraviolet photooxidation of the reduction product. (Contractor's abstract)

1935

Stanford Research Inst., Menlo Park, Calif.

SURVEY OF ELECTRON TRANSFER SPECTRA OF INORGANIC IONS, by R. J. Marcus. Dec. 1, 1959, 13p. incl. tables, refs. (Technical note no. 2; rept. no. 13) (AFOSR-TN-59-1322) (AF 18(603)7) AD 231930; PB 145670 Unclassified

The literature was searched for electron transfer spectra of inorganic ions. These are reported, together with the chemical evidence of light-induced electron transfer and with thermodynamic data needed for interpretation of the spectra. (Contractor's abstract)

1936

Stanford Research Inst., Menlo Park, Calif.

THE HILL REACTION AS A MODEL FOR CHEMICAL CONVERSION OF SOLAR ENERGY, by R. J. Marcus. Dec. 1, 1959, 9p. (Rept. no. 15) (AFOSR-TN-59-208) (AF 18(603)7) AD 231931; PB 161462 Unclassified

The possibility of storing solar energy for use during dark periods by decomposition of water into its elements was explored along 2 lines. One of these consisted of taking advantage of the electron transfer spectra of inorganic ions. These were surveyed and listed, together with chemical and thermodynamic correlative data. The conclusion was reached that electron transfer spectra corresponding to the evolution of hydrogen will always lie at the far ultraviolet end of the solar spectrum. The cause for this is an uncommonly high activation energy (of the order of 35 kcal/mol) in addition to the energy requirement for the intermediate H atom (48 kcal/mol). The other method consisted of a study of various Hill reaction oxidants. In the course of this study it was found that the efficiency of Hill reaction oxidants depended more on their energy levels than it did on their oxidation-reduction potentials, as

had been previously supposed. This was related, in turn, to the electron-transfer properties of chlorophyll itself.

Two new electron acceptors, $\text{Co}(\text{C}_2\text{O}_4)_3^{-3}$ and Cr^{+3} , were found to be active in the Hill reaction. (Contractor's abstract)

1937

Stanford Research Inst., Menlo Park, Calif.

MASS SPECTROMETER ANALYSIS OF THE VAPOR IN EQUILIBRIUM WITH THE ALKALI-METAL CHLORIDES, by T. A. Milne, H. M. Klein, and D. Cubicciotti. [1959] [2]p. incl. tables, refs. (AFOSR-TN-59-230) (AF 49(638)89) AD 264456 Unclassified

Also published in Jour. Chem. Phys., v. 28: 718-719, Apr. 1958.

A study is made, by mass spectrometric means, of the vapors in equilibrium and free evaporation from the alkali-metal halides. In a preliminary investigation of the vapors in equilibrium with the alkali-metal chlorides the observed ions and their relative intensities were found to exhibit some interesting trends relative to the problem of the importance of polymers in vapors of these salts. Tables of these data for chlorides of lithium, sodium, potassium, rubidium, and cesium are included. (ASTIA abstract)

1938

Stanford Research Inst., Menlo Park, Calif.

DETERMINATION OF RELATIVE PARTIAL PRESSURES FROM MASS SPECTROMETER ION INTENSITY MEASUREMENTS, by T. A. Milne. [1959] [2]p. (AFOSR-TN-59-231) (AF 49(638)89) AD 264457 Unclassified

Also published in Jour. Chem. Phys., v. 28: 717-718, Apr. 1958.

A method has been devised to permit a direct measurement of the proportionality of response of the mass spectrometer to the partial pressure for different polymeric species in equilibrium with the alkali-metal halides. Intensities are measured at 3 or more temperatures and are applicable to systems of more than 1 component. One restriction to the application of this method is for species whose partial pressures will be different in the 2 regions of the furnace due to some shift in gaseous equilibrium. (ASTIA abstract)

1939

Stanford Research Inst., Menlo Park, Calif.

LATTICE ENERGIES OF THE ALKALI HALIDES AND

AIR FORCE SCIENTIFIC RESEARCH

THE ELECTRON AFFINITIES OF THE HALOGENS, by D. Cubicciotti. July 1959 [22]p. incl. tables, refs. (AFOSR-TN-59-726) (AF 49(638)89) AD 225024; PB 143162 Unclassified

Also published in Jour. Chem. Phys., v. 31: 1646-1651, Dec. 1959.

The overlap repulsion parameters that occur in the Born-Mayer treatment of lattice energies have been re-evaluated for the alkali halides from recent compressibility data. With these parameters the lattice energies of the alkali halides were calculated. The lattice energies were combined with thermochemical data to calculate the electron affinities of the halogens. The values obtained were: F 80.2; Cl 85.0; Br 79.5; I 72.5 kcal/mol. (Contractor's abstract)

1940

Stanford Research Inst., Menlo Park, Calif.

ION-MOLECULE REACTIONS IN MASS SPECTROMETRIC STUDIES OF ALKALI HALIDE SALTS, by T. A. Milne. Dec. 1959, 8p. incl. table. (Technical note no. 5) (AFOSR-TN-59-1331) (AF 49(638)89) AD 231607; PB 145641 Unclassified

Also published in Jour. Chem. Phys., v. 32: 1275-1277, Apr. 1960.

An experiment was made to demonstrate directly and sensitively the contribution of ion-molecule reactions to the observed intensities of M_2Cl^+ under the experimental conditions used. A double orifice cell containing pure KCl in 1 chamber and pure NaCl in the other was used. A Bendix time-of-flight spectrometer with a 2-channel pulse counter and electron multiplier was utilized to detect individual ions formed. Some NaKCl⁺ was found; no clear evidence was noted of an ion-molecule reaction contribution to NaKCl⁺. An estimation was made that if ion-molecule reactions were the sole source of M_2X^+ , the ratio Na₂Cl⁺/NaKCl⁺ should be about 0.5. The conclusion was drawn that under these experimental conditions ion-molecule reactions account for less than 0.1% of the observed M_2X^+ .

1941

Stanford Research Inst., Menlo Park, Calif.

CALCULATION OF THE ENERGIES OF SOME ALKALI HALIDE TRIMERS, by T. A. Milne and D. Cubicciotti. [1959] [2]p. incl. diagr. table. (AFOSR-3468) (AF 49(638)89) Unclassified

Also published in Jour. Chem. Phys., v. 30: 1625-1626, June 1959.

The energies of formation of gaseous halide molecules from the monomers were calculated by means of a

model suggested by Pauling. The dimers were calculated to be 40 to 60 kcal more stable energetically than their separated monomers. The free energies of dimerization were calculated and used to predict the trends observed in the ratio of monomer to dimer for several salts. The energies of dimers were different cations were slightly more negative than the average of the 2-pure dimers.

1942

Stanford Research Inst., Menlo Park, Calif.

ENERGIES AND VIBRATIONAL FREQUENCIES OF GASEOUS ALKALI HALIDE M_2X^+ IONS, by T. A. Milne and D. Cubicciotti. [1959] [4]p. incl. diagrs. tables, refs. (AFOSR-3478) (AF 49(638)89) Unclassified

Also published in Jour. Chem. Phys., v. 30: 1418-1421, June 1959.

A potential function describing the interaction between the ions M_2X^+ molecules has been developed using a model suggested by Pauling. From this potential the energies and vibrational frequencies have been calculated for these molecules. The harmonic contributions to the bending frequencies are shown to be far from negligible based on this purely ionic model. The entropy and free energy changes for the reaction $M(g)^+ + MX(g) \rightarrow M_2X^+(g)$ are considered.

1943

Stanford Research Inst., Menlo Park, Calif.

LUMINESCENCE OF SOLIDS PRODUCED BY SURFACE RECOMBINATION OF ATOMS, by K. M. Sancier, W. J. Fredericks, and H. Wise. Mar. 1959 [2]p. incl. diagr. (AFOSR-TN-59-367) (AF 49(638)353) AD 213863 Unclassified

Presented at Symposium on Unstable Chem. Species, Los Angeles, Calif., June 23-24, 1958.

Also published in Jour. Chem. Phys., v. 30: 1355-1356, May 1959.

The research deals with an experimental investigation of converting to luminous energy of a solid the energy released from the heterogeneous recombination of atoms and other labile species. Theoretically such a process of energy transfer requires an overlap of the electronic energy levels of the recombining atom system with those of the solid. Further, in order that the transferred energy may be converted to light, the energy levels of the solid must be non-interacting, such as in a semi- or non-conductor. The intensity and spectral distribution of the luminescence of a solid activated by such means will be measured, the temperature effect of the solids determined, and the absorption spectra of the solids examined and compared with the energy levels of the atom systems.

AIR FORCE SCIENTIFIC RESEARCH

Furthermore, the surface energy levels in luminescent solids can be explored by measuring their absorption of low energy electrons or ions in the range of 0.2 to 20 ev. The solid phosphors will be selected from organic and inorganic substances, encompassing a range of excitation energies. This research will contribute to our basic knowledge of surface-catalyzed atom recombinations and of energy transfer between solids and gases. Also in propulsion systems it may lead to a reduction of the high surface temperatures encountered in hypersonic flight. (Contractor's abstract)

1944

Stanford Research Inst., Menlo Park, Calif.

LUMINESCENCE OF SOLIDS PRODUCED BY SURFACE RECOMBINATION OF ATOMS, by K. M. Sancier, W. J. Fredericks and others. June 15, 1959, 39p. incl. illus. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-59-716) (AF 49(638)353) AD 220729; PB 143297 Unclassified

During the heterogeneous recombination of atoms on surfaces of solid lumophors the energy released in the process may be converted to luminous energy of the lumophor. Lumophors based on the CaO and MgO host lattices and containing various activators were prepared. The luminescence characteristics of these materials when exposed to hydrogen, oxygen, and nitrogen atoms were examined. Included in this investigation are the effects of atom species, atom concentration, lumophor temperature, and lumophor composition. Some luminescence spectra were obtained. Photoluminescence and cathodoluminescence (in a hydrogen diffusion flame) of some of the lumophors were also examined. A model is presented which describes the processes of chemical reaction and energy transfer associated with luminescence produced by heterogeneous atom recombination. (Contractor's abstract)

1345

Stanford Research Inst. Poulter Labs., Menlo Park, Calif.

STUDIES IN THE THEORY OF SHOCK PROPAGATION IN SOLIDS. PART I. THE PERMANENT REGIME SOLUTION. PART II. FORMAL THEORY OF ANELASTICITY. PART III. STEADY-STATE COMPRESSION PROFILES PROPAGATING IN HEAT-CONDUCTING ANELASTIC SOLIDS, by W. Band. Sept. 3, 1959 [59]p. incl. diagrs. tables, refs. (AFOSR-TN-59-1280) (AF 49(638)625) AD 230167; PB 147515 Unclassified

Also published in Jour. Geophys. Research, v. 65: 695-719, Feb. 1960.

A theoretical treatment of compressive wave propagation in an anelastic solid is presented in 3 parts. (Part I.) A theory is developed for shock profiles in terms of a single parameter, defined as "shear-yield-

ing viscosity". Reasonable numerical estimates of the viscosity parameters for Al, Pb, Sn, and Zr are obtained by extrapolating the maximum slopes of the profiles as functions of the shock compressions to ideally complete compressions, and by relating the ultimate maximum slopes so derived to the material lattice spacing. (Part II.) Zener's linear theory of anelasticity has been generalized to materials with cubic crystal structure. The theory of the propagation and attenuation of plane waves, both longitudinal and transverse, along a principal axis of the crystal, is presented. The combined effects of relaxation mechanisms and thermal diffusion are included. The significance of the results for the theory of shock propagation are briefly discussed. (Part III.) The general equations for propagation of steady-state compression profiles in shear-yielding, heat-conducting anelastic solids are given. Methods of solution by successive approximation are developed for Hookean solids with both "adiabatic" and "isothermal" (very steep) profiles, and for shock profiles in non-Hookean solids. Correction terms compared with results of (I.) for the shock profiles are given for the thermal conductivity and anelastic effects. Heating after-effects of shocks are discussed. Calculation of the temperature of the solid after passage of a shock profile is shown.

1946

Stanford Research Inst. Poulter Labs., Menlo Park, Calif.

ATTENUATION OF THE SHOCK WAVE PRODUCED BY A FLYING PLATE, by G. R. Fowles. Aug. 20, 1959, 24p. incl. diagrs. table, refs. (AFOSR-TN-59-1281) (AF 49(638)625) AD 236852; PB 147684

Unclassified

Also published in Jour. Appl. Phys., v. 31: 655-661, Apr. 1960.

The attenuation of the plane shock wave produced in a solid by a flying plate of the same material is treated neglecting dissipative processes and effects of material rigidity. Explicit formulas for the position of the shock front and the shape of the pulse as functions of time are obtained by application of Friedrich's method. A numerical example for an aluminum target and projectile is presented to illustrate some of the features of the calculation, and an experiment is proposed to test the theory. The experiment should also allow a reasonably precise measurement of sound velocity immediately behind the shock front to be obtained. This possibility applies equally well to the case of target and projectile of different materials.

1947

Stanford Research Inst. Poulter Labs., Menlo Park, Calif.

FORMATION OF AN AMORPHOUS FORM OF QUARTZ

AIR FORCE SCIENTIFIC RESEARCH

UNDER SHOCK CONDITIONS, by P. S. De Carli and J. C. Jamieson. [1959] [2]p. [AFOSR-3660] [AF 49(638)-625] AD 613792
Unclassified

Also published in Jour. Chem. Phys., v. 31: 1675-1676, Dec. 1959.

Observations of change in quartz single crystals in a series of tests in which samples were recovered after shock loading are reported. Possible explanations for the formation of amorphous material from single crystals are presented.

1948

Stanford U. Applied Mathematics and Statistics Lab., Calif.

ON THE ADJOINT SEMIGROUP AND SOME PROBLEMS IN THE THEORY OF APPROXIMATION, by K. de Leeuw. Apr. 13, 1959 [34]p. (Technical note no. 3) (AFOSR-TN-59-214) (AF 49(638)294) AD 211776; PB 145742
Unclassified

Also published in Math. Zeitschr., v. 73: 219-234, Mar. 1960.

Results concerning the identification of saturation classes arising in the theory of approximation are extended to non-reflexive Banach spaces by the consideration of adjoint semigroups. (Contractor's abstract)

1949

Stanford U. Applied Mathematics and Statistics Lab., Calif.

ON THE DEGREE OF APPROXIMATION OF BERNSTEIN POLYNOMIALS, by K. de Leeuw. May 22, 1959 [24]p. (Technical note no. 4) (AFOSR-TN-59-402) (AF 49(638)294) AD 214522
Unclassified

Also published in Jour. Anal. Math. (Jerusalem), v. 7: 89-104, 1959.

A question concerning the degree of approximation of a function by its Bernstein polynomials is studied. All functions are determined for which the degree is $O(\frac{1}{n})$ and show that if the degree is $o(\frac{1}{n})$ on an interval, the function must be linear on that interval. (Contractor's abstract)

1950

Stanford U. Applied Mathematics and Statistics Lab., Calif.

TRANSLATION INVARIANT FUNCTION ALGEBRAS

ON ABELIAN GROUPS, by K. de Leeuw and H. Mirkil. Aug. 26, 1959, 45p. incl. refs. (Technical note no. 5) (AFOSR-TN-59-659) (AF 49(638)294) AD 225363; PB 143524
Unclassified

Also published in Bull. Soc. Math. (France), v. 88: 345-370, 1960.

Results are established concerning translation invariant uniformly closed subalgebras of the algebra $C_0(X)$ of continuous functions, zero at infinity, on a locally compact abelian group X . (Contractor's abstract)

1951

Stanford U. Applied Mathematics and Statistics Lab., Calif.

CONTINUOUS TRANSLATION OF HOLDER AND LIPSCHITZ FUNCTIONS, by H. Mirkil. Oct. 30, 1959, 18p. (Technical note no. 7) (AFOSR-TN-59-983) (AF 49(638)294) AD 229089; PB 144763
Unclassified

Also published in Canad. Jour. Math., v. 12: 674-685, 1960.

This paper attempts to solve the Plessner problems associated with various spaces of Hölder functions. It aims at an abstract Banach space formulation just general enough to include the Hardy-Littlewood results on integration of L_p spaces. A brief analysis of

Plessner's characterization of absolutely continuous functions is given based on the fact that there exist $f \in F$ such that the translate $T_x f$, defined by $(T_x f)(y) = f(x+y)$, does not vary continuously with x . The problem is to identify the $f \in F$ for which the mapping $x \rightarrow T_x f$ is continuous. Some general facts about continuous translation are also reviewed.

1952

Stanford U. Applied Mathematics and Statistics Lab., Calif.

THE ISOMETRIES OF H_1 , by K. de Leeuw. Nov. 30, 1959, 26p. (Technical note no. 8) (AFOSR-TN-59-1111) (AF 49(638)294) AD 231321; PB 145516
Unclassified

Linear isometries of H_1 onto itself are shown to be induced by conformal maps of the unit disk. Proof is presented of the following theorem: let t be a 1-1 conformal map of the unit disk onto itself and λ a complex constant with $|\lambda| = 1$. Then the mapping T defined by $Tf(z) = \lambda t'(z)f(t(z))$, $f \in H_1$, $|z| < 1$, is a linear transformation of H_1 onto itself that is an isometry, i.e., $\|Tf\| = \|f\|$, $f \in H_1$.

AIR FORCE SCIENTIFIC RESEARCH

1953

Stanford U. Applied Mathematics and Statistics Lab., Calif.

APPLICATIONS OF ALMOST PERIODIC COMPACTIFICATIONS, by K. de Leeuw and I. Glicksberg. Dec. 28, 1959 [63]p. incl. refs. (Technical note no. 9) (AFOSR-TN-59-1174) (AF 49(638)294) AD 231322; PB 145552 Unclassified

Almost periodic compactifications of operator semi-groups are constructed. Applications to the theory of weakly almost periodic functions and to ergodic theory are given. (Contractor's abstract)

1954

Stanford U. Applied Mathematics and Statistics Lab., Calif.

MULTIPLIERS OF COMMUTATIVE BANACH ALGEBRAS, by J.-K. Wang. Dec. 29, 1959, 36p. (Technical note no. 10) (AFOSR-TN-59-1288) (AF 49(638)294) AD 231323; PB 145507 Unclassified

Commutative Banach algebras A in which $x\mathbf{0} = \mathbf{0}$ implies $x = \mathbf{0}$ are considered. A multiplier of A is a mapping $T: A \rightarrow A$ satisfying $xTy = Tyx$. The multipliers of A are bounded linear operators and they form a commutative algebra $M(A)$, called the multiplier algebra of A . $M(A)$ is complete under the strong operator topology. A can be algebraically embedded in $M(A)$ as an ideal. When A is semi-simple, $M(A)$ is also semi-simple; and the maximal ideal space of A can be embedded in that of $M(A)$. If A is supremum norm algebra, so is also $M(A)$. In this case there are 3 natural topologies for $M(A)$: (1) the norm topology σ , (2) the strong operator topology β , and (3) the compact-open topology κ ; each being stronger than the following one. σ and β are equivalent if and only if A has a compact Silov boundary. Under suitable assumptions, β and κ are equivalent if and only if every countable union of compact subsets of the Silov boundary of A has a compact closure. The multiplier algebras of several special algebras are exhibited. (Contractor's abstract)

1955

Stanford U. Applied Mathematics and Statistics Lab., Calif.

THE REPRESENTATIONS OF LINEAR FUNCTIONALS BY MEASURES ON SETS OF EXTREME POINTS, by E. Bishop and K. de Leeuw. Oct. 28, 1959, 42p. incl. refs. (Technical note no. 6) (AFOSR-TR-59-133) (AF 49(638)294) AD 228266; PB 144348 Unclassified

Also published in Ann. Inst. Fourier, Grenoble, v. 9: 305-331, 1959.

The existence of representations of linear functionals

on subspaces and subalgebras of a Banach space by measures on boundaries smaller than the Silov boundary are discussed. (Contractor's abstract)

1956

Stanford U. Dept. of Aeronautical Engineering, Calif.

MECHANICS APPLIED TO CREEP TESTING; WILLIAM M. MURRAY LECTURE, by N. J. Hoff. Dec. 1958, 80p. incl. diagrs. tables, refs. (SUDAER no. 83) (AFOSR-TN-59-39) (AF 49(638)223) AD 238418 Unclassified

Presented at meeting of the Soc. for Experimental Stress Analysis, Albany, N. Y., Nov. 13, 1958.

The non-linearity of the creep laws governing the inelastic deformations of structural materials at high temperatures makes it difficult for the engineer to interpret correctly the results of creep tests and to predict the effect of small changes in the parameters upon the strain rates. It is the purpose of this paper to present information on the basis of which these tasks can be performed a little more easily. The causes of the large scatter in the results of creep tests, the effect of creep on the stress distribution, the interaction between linear elasticity and non-linear creep, and the difficulties encountered in the determination of the primary phase of creep are discussed with the aid of the principles of applied mechanics. The paper closes with a brief survey of instability phenomena. (Contractor's abstract)

1957

Stanford U. Dept. of Aeronautical Engineering, Calif.

A THEORY OF SMALL DEFORMATIONS OF SOLID BODIES, by J. F. Besseling. Feb. 9, 1959, 104p. incl. diagrs. refs. (SUDAER no. 84) (AFOSR-TN-59-605) (AF 49(638)223) AD 238419; PB 148754 Unclassified

A theory is presented which is capable of giving a mathematical description of the following phenomena observed in the deformation and heating of solid bodies: thermal stresses, thermoelastic damping of vibrations, dynamic and static moduli, Bauschinger effect and other anisotropic hardening phenomena in plastic deformation, primary creep preceding the secondary stage of steady creep under constant stress, creep recovery and stress relaxation. The variational principles of thermoelasticity, creep and of the theories of plasticity are all derived from 1 thermodynamic variational principle which is formulated with the aid of the entropy displacement field introduced by Biot. Thermoelastic damping of bending vibrations of beams and creep damping of pure shear vibrations are considered in some detail. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

1958

Stanford U. Dept. of Aeronautical Engineering, Calif.

THERMODYNAMIC FOUNDATIONS OF THE THEORY OF DEFORMATION, by J. F. Besseling. Aug. 1959, 26p. (SUDAER no. 86) (AFOSR-TN-59-871) (AF 49-638)223 AD 238420; PB 148503 Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 247-266. (AFOSR-TR-59-108)

It is shown that the theory of deformation can be founded on thermodynamic principles, the Galilean principle of relativity, and the concept of a natural reference state which at any instant is locally reproducible by a reversible process. The theory is a priori restricted to small inelastic strains. Explicit relations in terms of material properties are presented for small deviations from the natural reference state. Attention is drawn to the inherent nonlinearity of the thermoelastic equations in dynamic problems. (Contractor's abstract)

1959

Stanford U. Dept. of Aeronautical Engineering, Calif.

BUCKLING OF A THIN CIRCULAR CYLINDRICAL SHELL HEATED ALONG AN AXIAL STRIP, by D. W. Hill. Oct. 1959, 91p. incl. illus. diagrs. tables, refs. (SUDAER no. 88) (AFOSR-TN-59-1250) (AF 49(638)-223) AD 238421; PB 148504 Unclassified

A thin circular cylindrical shell was heated along a narrow strip in the axial direction. The restraint of the cooler portion causes compressive axial stresses in the heated strip, and if these stresses are sufficient in magnitude the cylinder can buckle into waves along the heated strip. The problem is solved using the Ritz method, assuming for the displacements Fourier series modified by a shape factor chosen to magnify the solution in the vicinity of the heated strip. The convergence rate of the solution is greatly increased by the shape factor. The cylinder is assumed to be simply supported on its ends so that the radial and circumferential displacements there are zero, but the axial displacements and end rotations are not restricted. The stresses caused by heating are assumed to vary around the circumference but to be constant in the axial direction. Expressions are given relating the physical parameters of the cylinder, the temperature distribution, and the magnitude of the temperature causing buckling. Experimental results for buckling tests on 11 cylinders are presented and are in reasonable agreement with the theoretical calculations. The modified Fourier series assumed for the displacements are shown to converge to the true solution as the number of terms included becomes indefinitely large. For practical purposes the convergence is so rapid that a single term gives results correct to within a few percent.

Courant's maximum-minimum principle is used to establish that the buckling stress for a cylinder under uniform axial compression is a lower bound for all other cases of axial loading, provided that the buckling stress is taken as the maximum compressive stress on the cross section. (Contractor's abstract)

1960

Stanford U. Dept. of Aeronautical Engineering, Calif.

PROCEEDINGS OF THE DURAND CENTENNIAL CONFERENCE ON AERONAUTICS AND ASTRONAUTICS, Stanford U., Calif. (Aug. 5-8, 1959), ed. by N. J. Hoff and W. G. Vincenti. New York Pergamon Press, 1960, 460p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-108) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)671, American Society of Mechanical Engineers, Institute of Aeronautical Sciences, Office of Naval Research, Office of Ordnance Research, and National Science Foundation) AD 253799 Unclassified

Nineteen papers were presented at a jointly sponsored conference covering such topics as rarefied gas dynamics, heat transfer, gas dynamics, material properties at hypersonic speeds, plasma dynamics, and accurate orbit and trajectory calculation as well as other areas of aeronautics and astronautics. Included among the papers are the following AFOSR supported reports: TN-59-790, item no. 2120, Vol. III; TN-59-871, item no. 1958, Vol. III; TN-59-1014, item no. 1891, Vol. III; TR-59-125, item no. 787, Vol. III; plus 2 additional reports. Magnetogasdynamic Problems from the Point of View of Particle Dynamics, by J. M. Burgers and Observation Requirements for Precision Orbit Determination, by S. Herrick, for which abstracts will be published in a future volume.

1961

Stanford U. Dept. of Chemistry, Calif.

KINETICS OF NITRIC ACID DECOMPOSITION IN HIGH TEMPERATURE SHOCK TUBE, by R. Hardwick, T. Harrison, and H. S. Johnston. Final technical rept. July 1959 [18]p. incl. diagrs. tables. (AFOSR-TR-59-121) (AF 49(638)306) Unclassified

The decomposition of nitric acid vapor in a shock tube was studied between 770 - 1240°K. The reaction was followed in terms of the appearance of nitrogen dioxide and in terms of the appearance and disappearance of the intermediate nitrate free radical, NO₃. The decomposition is the unimolecular reaction, HNO₃ + M -> HO + NO₂ + M, near its 2nd order limit. The rate is given by log k = 17.3 - (37.9 x 10³/RT), with k in cc mol⁻¹ sec⁻¹ and E in cal mol⁻¹; this result is in good agreement with low temperature data. The presence of the NO₃ radical and its rate of disappearance agree

AIR FORCE SCIENTIFIC RESEARCH

with previous work on nitric acid kinetics and nitrogen pentoxide kinetics. Eight reactions are simultaneously important in this system. The work confirms the observation of Schott and Davidson that above 1000°K the decomposition of NO_3 is unimolecular. (Contractor's abstract)

1962

Stanford U. Dept. of Physics, Calif.

HIGH-ENERGY ELECTRON SCATTERING AND THE CHARGE DISTRIBUTION OF CARBON-12 AND OXYGEN-16, by H. F. Ehrenberg, R. Hofstadter and others. [1959] [9]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)545], Atomic Energy Commission, and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 113: 666-674, Jan. 15, 1959.

The scattering of high-energy electrons from C^{12} , reported previously, has been extended to 420 mev. The elastic and inelastic scattering from the first excited level at 4.43 mev has been studied between 33° and 70°. The new data are in good agreement with the earlier measurements on C^{12} performed at 187 mev. Additional measurements of the elastic O^{16} -scattering cross sections of 240-, 360-, and 420- mev electrons as functions of the scattering angle furnish information on the size and shape of the O^{16} nucleus. Pronounced diffraction minima in the angular distributions were observed for C^{12} and O^{16} . The experimental results are compared with the predictions of a theoretical phase-shift analysis derived for the harmonic-well independent-particle model of the nucleus. Preliminary best fits confirm the shell-model predictions for the charge density distribution of the p-shell nuclei. The preliminary analysis of the data shows that the length parameter of the well is 1.66×10^{-13} cm for C^{12} , and 1.76×10^{-13} cm for O^{16} , thus indicating a slight variation of the curvature of the harmonic well as the p shell is filled in. (Contractor's abstract)

1963

Stanford U. [Dept. of Physics] Calif.

HIGHER ELECTROMAGNETIC CORRECTIONS TO ELECTRON-PROTON SCATTERING, by S. D. Drell and S. Fubini. [1959] [4]p. incl. diagr. refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)545] and Office of Naval Research) Unclassified

Published in Phys. Rev., v. 113: 741-744, Jan. 15, 1959.

Higher order electromagnetic corrections to the elec-

tron-proton scattering amplitudes are studied. The scattering amplitude is subjected to a dispersion analysis which permits the e^4 contribution to be written as the sum of two terms. The first corresponds to radiative corrections to the form factors, the second to virtual photon Compton scattering by the proton. A simple model is constructed for the resonant contribution to Compton scattering which is shown to correct the form factor analysis negligibly up to ~1 bev for all scattering angles. (Contractor's abstract)

1964

Stanford U. Dept. of Physics, Calif.

ON THE ANOMALOUS LOSS OF RESOLUTION OF PARAMAGNETIC RESONANCE HYPERFINE STRUCTURE IN LIQUIDS, by G. E. Pake and T. R. Tuttle, Jr. Sept. 1959 [6]p. incl. diagrs. [Technical note no. 2] (AFOSR-TN-59-1018) (AF 18(603)131) AD 230273; PB 145305 Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 423-425, Nov. 1, 1959.

The temperature dependence in the resolution of hyperfine splittings for paramagnetic molecules in liquid solution observed by Hausser is that with increasing temperature from a point of high solvent viscosity ultimately brings out a well-resolved structure which blurs and disappears at still higher temperatures. An explanation is proposed for this anomalous loss of structure by invoking theories of motional narrowing.

1965

Stanford U. Dept. of Physics, Calif.

THE INFLUENCE OF EXCHANGE INTERACTION OF PARAMAGNETIC RELAXATION TIMES, by J. P. Goldsborough, M. Mandel, and G. E. Pake. Nov. 1959 [11]p. incl. table, diagrs. (Technical note no. 3) (AFOSR-TN-59-1245) (AF 18(603)131) AD 230273; PB 145313 Unclassified

Also published in Phys. Rev. Ltrs., v. 4: 13-15, Jan. 1, 1960.

The spin-lattice relaxation and inverse line width at 10 kmc and 24 kmc are measured with a conventional magic tee microwave bridge for 1,3-bis(biphenylene)-2-phenylallyl (BDPA) and 1,1-diphenyl-2-picrylhydrazyl (DPPH) crystalized from CHCl_3 and C_6H_6 as well as in polystyrene solid solutions, and Wurster's blue perchlorate. Deviations are observed from results reported in previous studies with respect to dependencies in the polystyrene. The results are interpreted by a 3-reservoir model of Bloembergen and Wang.

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1966

Stanford U. Dept. of Physics, Calif.

TRIDENTS, μ -PAIRS, AND QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES, by J. D. B. Jorksen and S. D. Dreih. Jan. 1959 [26]p. incl. diagrs. table, refs. (Technical note no. 2) (AFOSR-TN-59-44) (AF 49(638)388) AD 209415 Unclassified

Also published in Phys. Rev., v. 114: 1368-1375, June 1, 1959.

Four experiments are proposed and discussed as tests of quantum electrodynamics, as applied to photons, electrons, and μ -mesons at distances $<10^{-13}$ cm. These are: (1) Electron-positron pair production by electrons in hydrogen (tridents); (2) Wide-angle photoproduction of μ -meson pairs in hydrogen with detection of one final meson; (3) Wide-angle photoproduction of μ -meson pairs in hydrogen with detection of both final mesons in coincidence; and (4) μ -meson pair-production by electrons in hydrogen. Taken together with wide-angle photoproduction of electron-positron pairs, which are discussed earlier, these experiments will extend knowledge of electron, photon, and μ -meson size to distance $\sim 0.3 \times 10^{-13}$ cm. They are all feasible for the Stanford linear accelerator operating in the 500-mev-1-bev energy range. (Contractor's abstract)

1967

Stanford U. Dept. of Physics, Calif.

NUCLEON STRUCTURE AND ELECTROMAGNETIC INTERACTION - THEORY, by L. I. Schiff. Sept. 1959, 27p. incl. diagrs. table, refs. (Technical note no. 3) (AFOSR-TN-59-900) (AF 49(638)388) AD 226977; PB 146471 Unclassified

Also published in Proc. Ninth Internat'l. Annual Conf. on High-Energy Phys., Kiev (USSR) (July 15-25, 1959), Moscow, 1960, p. 410-435.

This is a review paper reporting progress during the past year on the theoretical side of nucleon structure and electromagnetic interaction. The presentation is divided into 4 parts: (1) A consideration of corrections to the single-virtual photon approximation that can arise in electron scattering processes; (2) Information on nucleon form factors obtainable from experiments involving polarized particles, and from pion production; (3) Theory of the nucleon form factors; and (4) Possible breakdown of quantum electrodynamics at small distances. There are 46 domestic and foreign references cited covering a time period from 1957 to 1959.

1968

Stanford U. Dept. of Physics, Calif.

SPECTRAL REPRESENTATIONS OF GREEN'S FUNCTIONS IN PERTURBATION THEORY, by J. D. Bjorken. Sept. 1959, 41p. incl. diagrs. refs. (Technical note no. 4) (AFOSR-TN-59-948) (AF 49(638)388) AD 229094; PB 144764 Unclassified

An approach to the subject of quantum field theory is presented based upon the Feynman diagram expansion which has an intuitive appeal in the "unphysical" regions. The approach also exhibits the role of causality in determining analytic properties of scattering amplitudes, as well as showing the role of real intermediate states in determining their singularities. The physical idea involved in the development at the expense of mathematical precision is outlined. The integration of a Feynman graph is carried out over 4-momenta of internal loops in a general way. The Nambu representation, which exhibits analytic properties of the general Feynman diagram is derived. The analytic properties are shown to be determined by the existence of real causal intermediate states. The vertex operator is discussed as function of momentum transfer and its analytic properties are determined to all finite orders of the coupling constants. Scattering of particles of equal mass is also discussed. (Contractor's abstract)

1969

Stanford U. Dept. of Physics, Calif.

FLUX AT SEA LEVEL OF HEAVY CHARGED PARTICLES PAIR-PRODUCED IN COSMIC-RAY SHOWERS, by A. Goldberg. Sept. 1959 [8]p. incl. diagrs. refs. (Technical note no. 6) (AFOSR-TN-59-964) (AF 49(638)388) AD 229423; PB 144964 Unclassified

Also published in Phys. Rev., v. 117: 1128-1129, Feb. 15, 1960.

The flux at sea level of charged particles with mass 300-600 electron masses is calculated assuming the particles to be pair-produced by cosmic-ray photons. The cross section for pair production, including the effects of nuclear size, is folded into the distribution of photons predicted by shower theory. Absorption of the produced particles is also considered approximately. The results are well below the experimental upper limit set up by Keuffel and co-workers (Phys. Rev. Ltrs., v. 1: 203, 1958). (Contractor's abstract)

1970

Stanford U. Dept. of Physics, Calif.

INTERFERENCE EFFECTS IN HIGH-ENERGY

AIR FORCE SCIENTIFIC RESEARCH

BREMSSTRAHLUNG FROM CRYSTALS, by L. I. Schiff. Sept. 1959, 25p. incl. refs. (Technical note no. 5) (AFOSR-TN-59-965) (AF 49(638)388) AD 229408
Unclassified

Also published in Phys. Rev., v. 117: 1394-1401, Mar. 1, 1960.

An attempt is made to understand the negative results of Panofsky and Saxena (Phys. Rev. Ltrs., v. 2: 219, 1959), and the positive results of Frisch and Olson (Phys. Rev. Ltrs., v. 3: 141, 1959), in terms of the theory of the interference effects in high-energy bremsstrahlung from crystals, worked out by Überall (Phys. Rev., v. 103: 1055, 1956). Several theoretical approximations are examined in detail: the validity of the Born approximation, the calculation of temperature effects, the validity of the closure approximation for the crystal lattice, and the use of the Debye form for the lattice vibration spectrum. It is concluded that all of these are justified, except that a partial failure of the Born approximation may be responsible for the nonappearance of the central minimum in the Frisch-Olson experiment. The interference should be enhanced by making the primary electron energy as large as possible and the ratio of photon to electron energy as small as possible. In the case of a diamond-type crystal the 110 direction for the electron beam is preferred to the 100 or the 111 direction. Little advantage is to be gained from cooling the crystal. (Contractor's abstract)

1971

Stanford U. Dept. of Physics, Calif.

ON EXPERIMENTAL TESTS OF THE GENERAL THEORY OF RELATIVITY, by L. I. Schiff. Sept. 1959, 11p. incl. diagrs. (Technical note no. 7) (AFOSR-TN-59-1020) (AF 49(638)388) AD 229421
Unclassified

Also published in Amer. Jour. Phys., v. 28: 340-343, Apr. 1960.

The general theory of relativity is usually regarded as being supported by the 3 "crucial tests", i.e., (1) the red shift of spectral lines emitted by atoms in a region of strong gravitational potential, (2) the deflection of light rays that pass close to the sun, and (3) the precession of the perihelion of the orbit of the planet Mercury. The extent of its full structure supported by these 3 tests is evaluated. Both (1) and (2) are shown to be obtainable by using the equivalence principle and the special theory of relativity, which are amply supported by other experimental evidence. Only (3) provides a real test of general relativity. Terrestrial or satellite experiments that would go beyond merely supplying corroborative evidence for the equivalence principle and special relativity would be extremely difficult to perform, and would for example require a frequency standard with an accuracy somewhat better than 10^{-18} .

1972

Stanford U. Dept. of Physics, Calif.

PION-PION SCATTERING IN THE ϕ^4 THEORY, by M. Baker and F. Zachariasen. Dec. 1959, 22p. incl. diagrs. (Technical note no. 9) (AFOSR-TN-59-1324) (AF 49(638)388) AD 231747; PB 145642
Unclassified

Presented at meeting of the Amer. Phys. Soc., Honolulu, Hawaii, Aug. 27-29, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 368, Aug. 27, 1959.

Also published in Phys. Rev., v. 118: 1659-1664, June 15, 1960.

Pion-pion scattering was calculated using the determinantal method, assuming that a relativistic $(\lambda/4)$ $(\omega_1 \omega_2)^2$ coupling is responsible for the interaction. The scattering amplitude for the individual partial waves is expressed as a ratio of 2 power series and terms through λ^3 were kept in each series. Numerical results for the S- and P-waves were obtained. The term λ is adjusted by attempting to fit the electromagnetic structure of nucleons. The best value of λ obtained by this fit is unfortunately so large that the validity of the determinantal approximation is doubtful. (Contractor's abstract)

1973

Stanford U. Dept. of Physics, Calif.

SOME REMARKS ON COMPTON SCATTERING, by J. D. Walecka. Dec. 1959, 13p. incl. diagr. (Technical note no. 8) (AFOSR-TN-59-1332) (AF 49(638)388) AD 231746; PB 145640
Unclassified

The kinematics of Compton scattering are discussed and the general covariant form of the T-matrix written. This amplitude is written in the laboratory and center-of-momentum systems as an operator standing between Pauli (not Dirac) spinors. The entire spin and photon polarization dependence of the amplitude can be expressed in terms of 6 invariants involving $\vec{\sigma}$ matrices and the polarization vectors. The particular coefficients of these invariants coming from Powell scattering (a point anomalous moment) are given to 2nd order in the charge. (Contractor's abstract)

1974

Stanford U. [Dept. of Physics] Calif.

MEASUREMENT OF THE PROTON POPULATION RE-ADJUSTMENT TIME IN THE OVERHAUSER EFFECT OF FREE RADICALS (Abstract), by R. S. Rhodes and J. H. Burgess. [1959] [1]p. [AF 49(638)388] Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Presented at meeting of the Amer. Phys. Soc.,
Honolulu, Hawaii, Aug. 27-29, 1959.

Published in Buil. Amer. Phys. Soc., Series II, v. 4:
354, Aug. 27, 1959.

The nuclear population distribution undergoes a transient readjustment following a change in the electronic saturation factor in materials exhibiting the Overhauser effect. Measurements have been made of the readjustment time τ for protons in 3 organic free radicals in a magnetic field of 3100 oe. The power applied to the electronic transition was chopped at a variable audiofrequency. Proton absorption was observed with a marginal oscillator and phase-sensitive detector. The output signal was proportional to the difference between enhanced and normal nuclear absorption. The decrease of the output with increasing chopping frequency served to determine τ . The results for the free radicals DPPH, BLPA, and picryl-amino carbazyl are respectively 1.2 ± 0.2 , 1.3 ± 0.3 , and 1.6 ± 0.3 msec. Since the electronic spin-lattice relaxation time is 10^{-4} times that of the protons, the observed τ should be equal to the proton T_1 . For DPPH, τ agrees closely with a pulse measurement: $T_1 = 1.4 (\pm 0.1) \times 10^{-3}$ sec.

Although the technique described here can be used to measure the enhancement of the nuclear resonance, additional information is required to determine the branching ratios for the various nuclear relaxation paths.

1975

Stanford U. [Dept. of Physics] Calif.

FIXED-ANGLE DISPERSION RELATIONS FOR SCATTERING OF PARTICLES OF EQUAL MASS (Abstract), by J. D. Bjorken. [1959] [1]p. [AF 49(638)388]
Unclassified

Presented at meeting of the Amer. Phys. Soc.,
California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4:
448, Dec. 28, 1959.

By use of the Nambu representation, fixed-angle dispersion relations are derived in all orders of perturbation theory for the scattering of particles of equal mass. Singularities are confined to cuts along the real energy axis. If the lowest singularity for positive energy corresponds to a threshold of a physical process (in the physical region), partial-wave dispersion relations may be derived. This case is applicable to π - π and N-N scattering. In these cases, singularities along the negative real energy axis due to production processes lie beyond those due to 1- and 2-meson exchange terms. In cases of "anomalous thresholds," the fixed-angle dispersion relations can be derived, at best, for a range of angles more limited than $(-\pi, \pi)$.

1976

Stanford U. Div. of Engineering Mechanics, Calif.

SYNTHESIS OF THIRD ORDER CONTACTOR CONTROL SYSTEMS, by I. Flügge-Lotz. Oct. 15, 1959, 30p. incl. diagrs. refs. (Technical rept. no. 123) (AFOSR-TN-59-918) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)513, Boeing Airplane Co. under AF 33(600)35030, and National Aeronautics and Space Administration under NAW 6533) AD 228824; PB 145504 Unclassified

Presented at First Internat'l. Cong. of the Internat'l. Federation of Automatic Control, Moscow (USSR), 1960.

Also published in Automatic and Remote Control, v. 1:
390-397, 1960.

The transfer function of the uncontrolled linear dynamic system has 1 real and 2 complex poles and may have zeros. The system parameters change with operating conditions. A feedback contactor control with linear switching function is suggested; it can be realized easily and is efficient under different operating conditions. The design is based on the idea of approaching the most "optimum" control in those cases for which the latter is known. The influence of imperfections (time delay, threshold) on the performance of the control system is discussed. (Contractor's abstract)

1977

Stanford U. High-Energy Physics Lab., Calif.

SCINTILLATION PHENOMENA IN NaI AND CsF, by W. J. Van Sciver. Apr. 1955 [128]p. [Rept. no. HEPL-36] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) AD 63827
Unclassified

The spectra of the luminescence from Tl-activated and unactivated NaI and CsF crystals were measured in the temperature range -190°C to 125°C using α -particles, γ -rays, and UV light as sources of excitation. Results are presented graphically. An analysis is presented of factors contributing to scintillation emission following activation of crystals of NaI and CsF, and a qualitative explanation is presented of scintillation phenomena in NaI.

1978

Stanford U. [High-Energy Physics Lab.] Calif.

REVISED WEIZSÄCKER SEMI-EMPIRICAL FORMULA FOR DIFFUSE NUCLEAR SURFACES, by W. D. Gunter, Jr. and R. A. Hubbs. [1959] [4]p. incl. diagrs. table.

AIR FORCE SCIENTIFIC RESEARCH

[Rept. no. HEPL-153] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission and Office of Naval Research under [N6onr-25116])
Unclassified

Published in Phys. Rev., v. 113: 252-255, Jan. 1, 1959.

An attempt is made to modify the Weizsäcker semi-empirical mass formula to include effects of the diffuse nuclear surface indicated by recent electron scattering experiments. Volume and surface effects are combined by integrating over an assumed trapezoidal density function similar to that found experimentally. Good fits to the experimental nuclear masses are achieved with r_0 (a radius parameter) and c (half the surface depth) equal to 1.081×10^{-13} cm and 1.202×10^{-13} cm, respectively. These are in reasonably good agreement with the experimental values $(1.07 \pm 0.02) \times 10^{-13}$ cm and $(1.50 \pm 0.20) \times 10^{-13}$ cm found by Hahn, Ravenhall, and Hofstadter. (Contractor's abstract)

1979

Stanford U. High-Energy Physics Lab., Calif.

SEARCH FOR ENHANCEMENT OF BREMSSTRAHLUNG PRODUCED BY 575-MEV ELECTRONS IN A SINGLE CRYSTAL OF SILICON, by W. K. H. Panofsky and A. N. Saxena. Jan. 21, 1959 [5]p. incl. diag. (Rept. no. HEPL-161) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])
Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 219-220, Mar. 1, 1959.

An attempt to measure the enhancement of bremsstrahlung when the momentum transfer corresponds to a reciprocal lattice vector in a single crystal of silicon, irradiated by 575 mev electrons is made. X-rays were detected by production of positive pions, of energy defined by magnetic analysis, from a polyethylene target. No significant dependence of x-ray intensity on crystal orientation was found, which is contrary to the calculations of Überall. No explanation of the discrepancy has yet been found.

1980

Stanford U. [High-Energy Physics Lab.] Calif.

ABSOLUTE ELASTIC ELECTRON-SCATTERING CROSS SECTIONS OF Ca, V, Co, In, Sb, AND Bi AT 183 Mev (Abstract), by M. R. Yearian, J. Oeser, and R. H. Helm. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 61, Jan. 28, 1959.

The detector ladder described by Kendall has been used in measuring the elastic electron-scattering cross sections of Ca, V, Co, In, Sb, and Bi at several angles at 183 mev. Absolute cross sections are obtained by comparison with the scattering from hydrogen. The earlier work of Hahn, et al on the same elements yielded angular distributions which were analyzed by Ravenhall, using a Fermi 2-parameter model, in terms of c (radius to half-maximum), t (90% - 100% surface thickness), and the cross section $\sigma(\theta)$. Ford has analyzed these data using a very similar charge distribution and finds that in general there is an alternate solution characterized by values of c and t quite close to Ravenhall's best values, and by cross sections which vary from 0.6 to 0.85 of Ravenhall's values. Preliminary examination of the present work indicates that measured absolute cross sections are more nearly in agreement with those predicted by the original analysis than with those predicted by Ford's alternate solutions.

1981

Stanford U. [High-Energy Physics Lab.] Calif.

NEUTRON FORM FACTORS FROM HIGH-ENERGY ELECTRON-DEUTERON SCATTERING (Abstract), by S. Sobottka and R. Hofstadter. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Am. Phys. Soc., Series II, v. 4: 257, Apr. 30, 1959.

The inelastic electron-deuteron scattering cross section has been measured from 300 to 650 mev in order to improve the determination of F_{2n} and to place rough limits on F_{1n} . The data were analyzed in terms of the impulse approximation. Rough calculations by Jankus and Durand indicate that corrections due to final-state interactions may be important, so the analysis in terms of neutron form factors must remain incomplete until more satisfactory calculations appear. If these corrections are neglected and if F_{1n} is assumed to be zero, F_{2n}^2 appears to be about 25% larger than the proton form-factor at the smallest values of q^2 measured (2.65 to 5), the difference decreasing to zero at the largest values of q^2 measured (10 to 15.1). The final state interaction, correction would accentuate this

AIR FORCE SCIENTIFIC RESEARCH

difference. For $5.1 < q^2 < 12.8 \text{ f}^{-2}$, data were taken both at 135° and at a small angle (90° to 90°) for the same q . The results indicate that $-2.5 < (F_{1n}/F_{2n}) < 0.5$ for these q values.

1982

Stanford U. High-Energy Physics Lab., Calif.

SCATTERING OF 200-MEV POSITRONS BY ELECTRONS, by J. A. Poirier, D. M. Bernstein, and J. Pine. July 1959 [33]p. incl. diagrs. tables, refs. (Rept. no. HEPL-174) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under N6onr-25116)

Unclassified

Also published in Phys. Rev., v. 117: 557-565, Jan. 15, 1960.

Scattering of positrons by electrons has been investigated by bombarding a beryllium target with 200-mev positrons and observing the recoil electrons in a diffusion cloud chamber located behind the target. The cloud chamber was in a magnetic field which permitted the yield of recoil electrons to be measured as a function of their energy W . The experiment covered the range $88 \leq W \leq 200$ mev. The positron beam also traversed the cloud chamber and the total number of incident positrons was determined by track-counting. The total electron yield for $88 \leq W \leq 200$ mev is $(11 \pm 9)\%$ below that predicted by the first-order Bhabha theory. This difference cannot be interpreted until radiative corrections to the theory have been evaluated. A calculation of these corrections which is valid for the conditions of this experiment is not available. The shape of the electron energy spectrum is in good agreement with the Bhabha theory, and inconsistent with the theory if annihilation terms are omitted. (Contractor's abstract)

1983

Stanford U. High-Energy Physics Lab., Calif.

INELASTIC ELECTRON SCATTERING FROM CARBON, by W. C. Barber and F. E. Gudden. [1959] [7]p. incl. diagr. (Rept. no. HEPL-177) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])

Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 219-221, Sept. 1, 1959.

The energy spectrum of electrons inelastically scattered from nuclei was measured in order to study the giant-resonance region of nuclear excitation. The scattered electrons corresponding to excitation of the giant resonance were observed at large angles for Si and C targets. The energy distribution of electrons scattered from C at energy level of 42.6 mev through 160° was

described in some detail. A scattering peak corresponding to a nuclear excitation of 15 mev was observed. The results indicate that the investigation of nuclear properties by inelastic electron scattering can be extended to other types of nuclear excitation and can be carried out with lower-energy electron beams.

1984

Stanford U. High-Energy Physics Lab., Calif.

INELASTIC SCATTERING OF 500-MEV ELECTRONS FROM Li^6 AND Li^7 , by U. Meyer-Berkhout. [1959] [4]p. incl. diagrs. table. (Rept. no. HEPL-190) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])

Unclassified

Published in Phys. Rev., v. 115: 1300-1303, Sept. 1, 1959.

500-mev electrons have been scattered from enriched Li^6 and ordinary Li (92.5% Li^7) between scattering angles of 60° and 135° in the laboratory system. The cross section integrated over the inelastic continuum at these large momentum transfers has been compared with the free-proton cross section at the corresponding angles. The results when compared with those obtained for other light nuclei may be used to yield some insight as to the extent to which the scattering from the individual nucleons can be considered as incoherent. (Contractor's abstract)

1985

Stanford U. [High-Energy Physics Lab.] Calif.

THE FUTURE OF HIGH ENERGY ACCELERATORS IN PHYSICS, by W. K. H. Panofsky. [1959] [4]p. [Rept. no. HEPL-180] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])

Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 3-6.

Problems concerning the use of ultra-high energy accelerators expected to be used in the future are discussed. Various experiments are considered which will require higher energies and higher intensities than are now available.

1986

Stanford U. [High-Energy Physics Lab.] Calif.

BEAMS FROM HIGH ENERGY LINEAR

AIR FORCE SCIENTIFIC RESEARCH

ACCELERATORS, by W. K. H. Panofsky. [1959] [2]p. [Rept. no. HEPL-197] [Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under N6onr-25116] Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 427-428.

Some general remarks are given concerning the properties of beams from high energy lines and the use of these beams. The particular features are: (1) The total beam will be available as an external beam of excellent geometrical properties. (2) The duty cycle is much lower than in any of the other machines discussed. (3) The pulse length can be reduced to about 20 ns total duration with only a relatively small loss of particles per pulse. (4) Secondary beams at small angles including 0° can be brought out for all polarities and all beam energies without fundamental difficulties. (5) The thin target bremsstrahlung angle is of the order of 0.01 mrad. (6) Some background problems may exist since the primary beam is not automatically separated from the secondary beam causing special disposal problems. The use of these beams is discussed with emphasis on the difference between thin target and thick target operation.

1987

Stanford U. [High-Energy Physics Lab.] Calif.

EXPERIENCE WITH A MICROWAVE SEPARATOR, by W. K. H. Panofsky. [1959] [4]p. incl. diagrs. table. [Rept. no. HEPL-196] [Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116] Unclassified

Published in Proc. Internat'l. Conf. on High-Energy Accelerators and Instrumentation - CERN 1959, Geneva (Switzerland) (Sept. 14-19, 1959), Geneva CERN, Scientific Information Service, 1959, p. 428-431.

The results obtained from the microwave separator, designed, constructed and tested earlier by P. R. Phillips in connection with the Mark III 700 mev linear accelerator are discussed.

1988

Stanford U. High-Energy Physics Lab., Calif.

CHARGE DISTRIBUTIONS OF NUCLEI OF THE 1p SHELL, by U. Meyer-Berkhout, K. W. Ford, and A. E. S. Green. [1959] [55]p. incl. diagrs. tables, refs. (Rept. no. HEPL-187) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) Unclassified

Published in Ann. Phys., v. 8: 119-171, Sept. 1959.

New data have been obtained at energies of 160 to 420 mev for the scattering of electrons by Be⁹, B¹⁰, B¹¹, N¹⁴, and O¹⁶. A detailed analysis of these elastic scattering data and of other available data for p-shell nuclei is carried through, using various methods and a wide variety of assumed functional forms of the nuclear charge distribution. It is possible to fix rather accurately the spherically symmetric part of the charge distributions of Li⁶, C¹², N¹⁴, and O¹⁶, and with less accuracy, those of Be⁹ and B¹¹. Central densities are uncertain in all cases. Quadrupole scattering appears to be important in N¹⁴, in B¹¹, and possibly in Be⁹, and a crude estimate of the quadrupole moment of N¹⁴ is inferred from the data. The quadrupole scattering depends sensitively on the source of the quadrupole moment, as well as on its value. Regularities within the p-shell are discussed, and connection made with the properties of heavier nuclei. Be⁹ and all heavier nuclei have a common value of peak particle density corresponding to a mean particle spacing of $(1.13 \pm 0.001) \times 10^{-13}$ cm. Only Li⁶ fails to reach this density of saturated nuclear matter. (Contractor's abstract)

1989

Stanford U. High-Energy Physics Lab., Calif.

MAGNETIC QUADRUPOLE WITH RECTANGULAR APERTURE, by L. N. Hand and W. K. H. Panofsky. [1959] [4]p. incl. diagrs. tables. (Rept. no. HEPL-169) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) Unclassified

Published in Rev. Scient. Instr., v. 30: 927-930, Oct. 1959.

A magnetic quadrupole of rectangular aperture, employing current sheets bounded by iron rather than shaped pole faces to establish the field, is described. The performance of a rectangular quadrupole of aperture 4 x 23 in. is reported. (Contractor's abstract)

1990

Stanford U. High-Energy Physics Lab., Calif.

APPLICATION OF SUM RULES TO ELECTRON-DEUTERON SCATTERING, by J. I. Friedman. [1959] [6]p. incl. diagrs. tables, refs. (Rept. no. HEPL-172) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116]) Unclassified

Published in Phys. Rev., v. 116: 1257-1262, Dec. 1, 1959.

AIR FORCE SCIENTIFIC RESEARCH

A measurement of elastic and inelastic electron-deuteron scattering has been made at a momentum transfer of 205 mev/c and an electron energy of 175 mev for comparison with the Drell-Schwartz sum rules. The measured value of the non-energy-weighted sum rule is in good agreement with theory. The experimental result for the energy weighted sum rule is 30% larger than the value given for a pure Wigner potential and is consistent with a Rosenfeld two-body interaction if the analysis is restricted to central forces. The analysis is extended to include tensor forces for comparison with the prediction of the Gartenhaus potential. It is found that the gauge terms introduce major ambiguities when tensor forces are included.

1991

Stanford U. High-Energy Physics Lab., Calif.

NEUTRON YIELDS FROM TARGETS BOMBARDED BY ELECTRONS, by W. C. Barber and W. D. George. [1959] [9]p. incl. diagrs. tables, refs. (Rept. no. HEPL-150) (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])

Unclassified

Published in Phys. Rev., v. 116: 1551-1559, Dec. 15, 1959.

The total neutron yields from thick targets bombarded by electrons were measured as a function of electron energy for the range 10 to 36 mev. Targets ranging in thickness from 1 to 6 radiation lengths of C, Al, Cu, Ta, Pb, and U were used. The yields for 1- and 6-radiation-length targets of Pb at 24 mev are 2.1×10^{-3} and 9.0×10^{-3} neutrons/electron. Extrapolation to infinite target thickness gives a value of 9.5×10^{-3} neutron/electron. The yield, comparing targets of 1 radiation length, from C is about 10 times smaller than that from U and 2 times greater than the yield from Pb. An explanation of the relative Z-dependence of the yield in terms of known photonuclear cross sections is successful to within a factor of 1.5. The absolute accuracy of the results is estimated to be $\pm 15\%$. Calibration of the neutron-detecting equipment was made with a RaBe source and checked by measuring the yields, due to electro- and photodisintegration of the deuteron, from a heavy-water target. In addition, yields from thin targets of Be and Cu were observed as a function of electron energy. The data for Be yield a value of (0.018 ± 0.003) mev-barn for the (γ, n) cross section integrated to 17 mev. The data for Cu were analyzed and combined with other measurements to give an approximate cross section for the $\text{Cu}(\gamma, pn)$ reaction.

1992

Stanford U. High-Energy Physics Lab., Calif.

POSITIVE PION PRODUCTION BY POLARIZED

BREMSSTRAHLUNG, by R. E. Taylor and R. F. Mozley. [1959] [11]p. incl. diagrs. tables, refs. [Rept. no. HEPL-162] (Sponsored jointly by Air Force Office of Scientific Research, Atomic Energy Commission, and Office of Naval Research under [N6onr-25116])

Unclassified

Published in Phys. Rev., v. 117: 835-845, Feb. 1, 1960.

By selecting bremsstrahlung produced in a 0.003-in. aluminum radiator at a small angle from the original electron direction, a beam of polarized bremsstrahlung has been obtained from the Stanford linear accelerator. The variation of the polarization and intensity with angle has been studied and compared with theoretical predictions. The polarized beam has been used to study π^+ -meson production at 90° c.m. angle and photon energies of 242, 296, 337, and 376 mev. The ratio of meson production along and at right angles to the electric field vector has been measured and compared with the values predicted by the relativistic dispersion relation. (Contractor's abstract)

1993

Stanford U. Microwave Lab., Calif.

NOTE ON UNIQUE DECIPHERABILITY, by E. T. Jaynes. Jan. 1959 [13]p. incl. diagrs. (ML rept. no. 567) (AFOSR-TN-59-52) (AF 49(638)342) AD 209423

Unclassified

Also published in I.R.E. Trans. on Inform. Theory, v. IT-5: 98-102, Sept. 1959.

Consideration is given to an alphabet of a letters, used under the restrictions: (1) messages uniquely decipherable into words, and (2) words limited to a maximum length of L letters. Defining "semi-optimal" transmission by the condition that the mean transmission time per word is minimized for a given entropy per word, we find the attainable rate of information transmission under semi-optimal conditions. Transmission at full channel capacity is a special case of semi-optimal transmission. The constraint of unique decipherability causes no decrease in capacity of the alphabet, considered as a channel, unless accompanied by other constraints. Accordingly, in the absence of other constraints an inequality of McMillan pertaining to uniquely decipherable messages is actually an equality. Some generalizations and analogies to statistical mechanics are discussed. (Contractor's abstract)

1994

Stanford U. Microwave Lab., Calif.

A PROPOSED MILLIMETER-WAVE GENERATOR, by G. S. Kino. Sept. 1959, 18p. incl. refs. (ML rept. no. 606) (AFOSR-TN-59-890) (AF 49(638)415) AD 227664

Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in Proc. Symposium on Millimeter Waves, New York, N. Y. (Mar. 31-Apr. 2, 1959), Brooklyn, Polytechnic Inst. of Brooklyn Press [1960] p. 233-248.

A mm-wave generator, using a waveguide filled with a plasma of uniform cross-sectional density, but with an axial density variation of the form $\rho_0(1 + \alpha \sin \gamma z)$, is discussed. It is shown, by solving the wave equation for the system, that slow-wave space harmonics of the normal waveguide mode are set up which can interact with an electron beam. These space harmonics, although usually of small amplitude, can have the property that their electric fields are maximum at the center of the guide and minimum at its walls. The design of a possible 1-mm backward-wave oscillator operating at 2.5 kv with approximately 12 ma starting current is dealt with. This design is postulated on the assumption that the so-called Langmuir "electrostatic sound waves" or similar modes may be used to set up the necessary density variation in the plasma. (Contractor's abstract)

1985

Stanford U. Microwave Lab., Calif.

THE EXCITATION OF PLASMA OSCILLATIONS, by P. A. Sturrock. Sept. 1959, 12p. incl. diagrs. refs. (ML rept. no. 633) (AFOSR-TN-59-891) (AF 49(638)-415) AD 227516 Unclassified

Also published in Phys. Rev., v. 117: 1426-1429, Mar. 15, 1960.

The theory of Bohm and Gross [Phys. Rev., v. 75: 1851 and 1864, 1949] and the experiments of Looney and Brown [Phys. Rev., v. 93: 965, 1954] upon the excitation of plasma oscillations by the 2-stream mechanism, which appear superficially to be in disagreement, are shown to be compatible with each other and with related experiments. (Contractor's abstract)

1996

Stanford U. Microwave Lab., Calif.

ACTION-TRANSFER AND FREQUENCY SHIFT RELATIONS IN THE NONLINEAR THEORY OF WAVES AND OSCILLATIONS, by P. A. Sturrock. Sept. 1959, 18p. incl. diagrs. refs. (ML rept. no. 625) (AFOSR-TN-59-892) (AF 49(638)415) AD 227663

Unclassified

Also published in Ann. Phys., v. 9: 422-434, Mar. 1960.

Certain relations which have arisen in the theories of electrical networks, electron tubes, plasma oscillations and particle accelerators are here shown to be special cases of general relations attributable to any system which may be described by a Hamiltonian. If such a system is analyzed into an interesting set of modes

(waves or oscillators), we find that the rates of transfer of action to or from members of a group of interacting modes are in integral ratios, the integers being determined by the interaction, and are related in magnitude to the energy associated with the interaction. We find furthermore a conjugate set of relations which lead to the following statement: the fractional shifts in frequency of members of a group of interacting modes, when multiplied by the energies in those modes, are in integral ratios, the integers being determined by the interaction, and are related in magnitude to the energy associated with the interaction. The "action-transfer relations" allow one to draw a close parallel between the nonlinear theory of propagating media and the quantum or classical theories of particle collisions. These relations are closely related to the Poincaré and adiabatic invariants. The "frequency-shift relations" provide useful information relating the frequencies of uncoupled modes and the frequencies of excitation of these modes to the partition of energy of this excitation among these modes. This application is demonstrated by a simple example. (Contractor's abstract)

1997

Stanford U. Microwave Lab., Calif.

GROWING SPINWAVES IN FERRITES IN UNSTABLE EQUILIBRIUM, by T. Schaug-Pettersen. [1959] [2]p. (AFOSR-TN-59-1184) [AF 49(638)415]

Unclassified

Presented at Conf. on Magnetism and Magnetic Materials, Detroit, Michigan, Nov. 16-19, 1959.

Also published in Jour. Appl. Phys., Suppl., v. 31: 382S-383S, May 1960.

It is demonstrated that when the direction of the magnetic field in a saturated ferrite is inverted, spin waves occur which have an aperiodic exponential growth. The fastest growing of these waves have the time factor $\exp(\Omega_M t/2)$ and their wave vector is oriented at right angles to the magnetic field. The significance of these waves for ferrite switching and microwave pulse generation is discussed briefly. (Contractor's abstract)

1998

Stanford U. Microwave Lab., Calif.

SATURATION EFFECTS IN FERRIMAGNETIC RESONANCE, by P. E. Seiden and H. J. Shaw. Oct. 1959 [2]p. incl. diagrs. (ML rept. no. 653) (AFOSR-TN-59-1185) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)415] and Lockheed Missiles and Space Division)

Unclassified

Presented at Conf. on Magnetism and Magnetic Materials, Detroit, Michigan, Nov. 16-19, 1959.

AIR FORCE SCIENTIFIC RESEARCH

Also published in Jour. Appl. Phys., Suppl., v. 31: 225S-226S, May 1960.

Saturation curves of susceptibility as a function of rf magnetic field have been measured for a number of samples of polycrystalline yttrium iron garnet of varying linewidth. The curves exhibit a region of susceptibility linear in $1/h_{rf}$ at high rf powers. The region of the initial decline in susceptibility is linear in h_{rf}^2 , which is predicted both by a small signal relation derived from Callen's ferromagnetic dynamical equation and by a calculation of Schlömann which includes inhomogeneity interactions. A new method of determining the critical field for spinwave build-up is discussed. This method takes account of the fact that the initial decline in susceptibility is not simply due to the Suhl mechanism for saturation in ferrites.

1999

Stanford U. Microwave Lab., Calif.

FERRIMAGNETIC RESONANCE IN POLYCRYSTALLINE YTTRIUM IRON GARNET, by P. E. Seiden. Oct. 1959, 76p. incl. illus. diagrs. tables, refs. (ML rept. no. 657) (AFOSR-TN-59-1186) (AF 49(638)415) AD 230374; PB 145017 Unclassified

Investigation was made to obtain a more complete description of the resonance parameters of the yttrium iron garnet system at both small signal and high power levels. A number of sets of polycrystalline samples were made whose composition varied in a systematic way. The composition was varied by choosing the desired ratio of Y_2O_3 to Fe_2O_3 used in the manufacture of the samples. The finished samples ranged from 25% Fe excess through stoichiometric proportions to 15% Y excess. In preparing the samples, 4 different firing atmospheres were used (air, O, N, and Ar) to obtain different states of sample oxidation. A number of sets were fired in each atmosphere to evaluate reproducibility. Ferrimagnetic resonance experiments were performed at 9317 mc, and the linewidth, g-value and saturation curves of microwave susceptibility as a function of RF magnetic field strength were obtained. In addition, saturation magnetization and x-ray diffraction measurements were made and photomicrographs of the samples were taken. The x-ray diffraction data and photomicrographs show that no substitution occurred in the garnet lattice and all excess material went into ceramic second phases. These phases show up clearly in the photomicrographs as regions of approximately the size of a few crystallites. The phases observed were $YFeO_3$ for Y excess, Fe_2O_3 for Fe excess samples fired in oxidizing atmospheres, and Fe_3O_4 for samples fired in neutral atmospheres. Theoretical values for the saturation magnetization, g-value and linewidth of the samples were calculated.

2000

Stanford U. Microwave Lab., Calif.

HIGH-POWER EFFECTS IN FERRIMAGNETIC RESONANCE, by P. E. Seiden and H. J. Shaw. Mar. 1959 [2]p. (ML rept. no. 586) (AF 49(638)415) Unclassified

Also published in Jour. Appl. Phys., v. 31: 432-433, Feb. 1960.

During ferrimagnetic resonance experiments at high power levels in yttrium iron garnet (YIG), small, sharp discontinuities in susceptibility, superimposed upon the continuous decline with increased power seen by earlier workers, have been noted as many as 9 discontinuities in 1 sample. The size of the discontinuity, and the numbers are roughly inversely proportional to the sample line width. The occurrence follows the empirical relation $h^2 = k \exp(n/c)$, where n is the no. of the discontinuity, in order of occurrence; k and c are constants. For most samples having a large no. of discontinuities, c lies between 1.2 and 3.2. Two other associated effects have also been noted. One is a similar effect when the RF power level is set at a value above the 1st discontinuity and the frequency varied. The other is the occurrence of a region of instability just after the 1st discontinuity.

2001

Stanford U. Microwave Lab., Calif.

HIGH-POWER EFFECTS IN FERRITE DEVICES, by P. E. Seiden and H. J. Shaw. Apr. 1959 [2]p. (ML rept. no. 602) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)415 and Lockheed Missiles and Space Division) Unclassified

Also published in Proc. Inst. Radio Engineers, v. 48: 122-123, Jan. 1960.

The performance of ferrite devices deteriorates at power levels much lower than would be expected by analogy with saturation in effects in paramagnetic resonance. The effect is due to unstable growth of spin waves which extract energy from the uniform precession. The threshold for the onset of susceptibility decrease depends on the RF field, the linewidth of the sample, the saturation magnetization and the linewidth of the spinwave which becomes unstable. Measurements of linewidth and threshold were made and spinwave linewidth calculated. Values of the critical field threshold power are derived and compared with experimental results.

2002

Stanford U. Microwave Lab., Calif.

INTERPRETATION OF THE RESULTS OF THE RF

AIR FORCE SCIENTIFIC RESEARCH

CONFINEMENT EXPERIMENT, by P. A. Sturrock. Oct. 1958, 25p. incl. diagrs. table. (Scientific rept. no. 3; ML rept. no. 638) (Sponsored jointly by Air Force Cambridge Research Center under AF 19(604)5226 and Air Force Office of Scientific Research under [AF 49-(638)415]) Unclassified

The results of certain experiments upon the confining action of low frequency (about 10 mc/s) rf fields upon plasmas are reviewed. Attempts at theoretical explanation of these results by various confinement mechanisms also are reviewed. The theories are not found acceptable, and there are certain general reasons for believing that the experiments do not represent true confinement. Investigation of the electric field configuration necessary to explain the observed plasma configuration leads one to interpret the experiment in terms of "pseudo-confinement". Surface charges build up on the inner wall of the glass tube in such a way that electrons experience a radially inward force at the surface of the plasma over almost all of the surface of the plasma almost all of the time; ions therefore experience an outward force almost everywhere most all of the time. The effect of the rf electric field is therefore to promote the formation of a high-voltage sheath separating the plasma from the glass tube. This interpretation appears to be fully compatible with observations so far made with various electric-field patterns; it also offers an explanation of the dark deposits on the glass tube noted in certain experiments. Further experiments which may be conducted to verify this theory are proposed. (Contractor's abstract)

2003

Stanford U. Microwave Lab., Calif.

THE DESIGN AND CHARACTERISTIC OF A MEGA-WATT SPACE-HARMONIC TRAVELING-WAVE TUBE, by M. Chodorow, E. J. Nalos and others. [1959] [5]p. incl. illus. diagrs. refs. [ML rept. no. 501] (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under [N6onr-25123]) Unclassified

Published in I.R.E. Trans. on Electron Devices, v. ED-6: 48-53, Jan. 1959.

The tube described has a pulsed output power of 1 megawatt with 9.6% bandwidth, where bandwidth is defined as the 3 db points for saturation power. Saturation gain is about 20 db, which is 6 db below the low-level gain. This is a space-harmonic S-band structure, designed to operate at a beam voltage of 10^5 v and perveance of 2×10^{-6} . Field configurations for the lowest and next higher pass bands are drawn, based upon a field analysis and cold measurements. The impedance determined by perturbation measurements is compared to the impedance for the forced sinusoid inside a closed region, and it is found that the tube has about 4 times the minimum storage energy necessary to obtain the same bandwidth. (Contractor's abstract)

2004

Stanford U. Microwave Lab., Calif.

DEVELOPMENT OF HIGH-POWER PULSED KLYSTRONS FOR PRACTICAL APPLICATIONS, by M. Chodorow, E. L. Ginzton and others. [1959] [10]p. incl. illus. diagrs. tables. (ML rept. no. 496) (Sponsored jointly by Air Force Office of Scientific Research, and Signal Corps under [N6onr-25123]) Unclassified

Published in Proc. Inst. Radio Engineers, v. 47: 20-29, Jan. 1959.

The development of 3 practical, sealed-off, tunable klystrons intended for operation in the region of 1 to 2 megawatt at S, L, and X-bands is described. These tubes are an outgrowth of previous development of a 30 megawatt S-band klystron in conjunction with the billion-volt linear electron accelerator program. Similar design principles apply to all these tubes, but the 3 smaller klystrons described make use of cavity tuning methods appropriate to the 3 frequency bands.

2005

Stanford U. Microwave Lab., Calif.

MICROWAVE TUBE RESEARCH, by E. L. Ginzton and M. Chodorow. Final rept. Mar. 1, 1950-Mar. 30, 1959, 79p. incl. illus. (ML rept. no. 590) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under N6onr-25123) AD 213845 Unclassified

An historical survey of the purposes and accomplishments of Contract N6onr-25123 is presented. Also presented are a list of the Technical Reports which have been issued under this contract; a list of the Doctoral degrees which have been awarded to graduate students whose thesis research has been wholly or partially sponsored by this contract; and a list of the scientific personnel who have been associated with the contract. Illustrations of some of the devices and schemes which have been developed or investigated under this contract are also presented. (Contractor's abstract)

2006

Stanford U. Microwave Lab., Calif.

ON THE BOUNDARY VALUE PROBLEM OF WAVEGUIDE WINDOWS, by M. P. Forrer. Mar. 1959, 111p. incl. illus. tables, refs. (ML rept. no. 579) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under N6onr-25123) AD 215820 Unclassified

The mode conversion theory is generalized to the case of arbitrary dielectric obstacles, and applied to the problem of the vicinity of dielectric waveguide windows

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of general shape. Results are compared with experimental measurements to determine the validity of the approximate methods used. The mathematical method is that of a normal mode expansion of the electromagnetic fields. The contribution of individual waveguide modes to the total field may be determined by successive approximations. The theory is applied to several specific window geometries where a perturbation procedure is used, based on an expansion of the fields in powers of $(\epsilon - 1)$. The comparison between theory and experiment is done by way of the reflection coefficient. First-order solutions are accurate for windows of low dielectric constant ($\epsilon < 4$) and small length. Improvements obtainable by second-order approximation are illustrated. For windows of high dielectric constant ($\epsilon \approx 10$) and a length of the order of a guide wavelength, there is strong modal interaction, so that the first-order solutions are only qualitatively correct. Accurate results for this case must be obtained by numerical integration of the coupled differential equations of several modes. This problem is well adapted to programming on a computer. The phenomenon of ghost-modes in dielectric windows is discussed. (Contractor's abstract)

2007

Stanford U. Microwave Lab., Calif.

COUPLING OF MULTIPLE-CAVITY SYSTEMS, by M. A. Allen. Apr. 1959, 161p. incl. illus. tables, refs. (ML rept. no. 584) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under N6onr-25123) AD 215455 Unclassified

Cavity resonators, coupled together by various methods, were used as circuits in a number of high-power TWT. The resonators are coupled together in a long array with a means provided for an electron beam to pass through a region of strong longitudinal electric field. Work is concerned primarily with the type of coupling obtained through long resonant slots. In particular, new types of structures which employ slots of lower resonant frequency than the uncoupled cavities are considered, and it is shown that they have very large bandwidths and high impedance, and are therefore desirable circuits for use in wide-band high-power TWT. An electromagnetic field theory is given which successfully predicts the important propagation characteristics of these structures. It is shown how

the quantity $E^2(O)/W$ for the structures may be evaluated, where $E(O)$ is the value of the longitudinal component of the electric field on the axis, and W is the energy stored per periodic length. With this information, the usefulness of the structures as traveling-wave tube circuits may be assessed. (Contractor's abstract)

2008

Stanford U. Microwave Lab., Calif.

EXTENDED INTERACTION KLYSTRONS WITH TRAVELING-WAVE CAVITIES, by H. Golde. Apr. 1959, 131p. incl. illus. diagrs. tables, refs. (ML rept. no. 582) (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under N6onr-25123) AD 215453 Unclassified

Study was made of a new type of extended interaction cavity for klystrons. The interaction cavity consists of a closed transmission line loop which will support a traveling wave if the loop is properly excited. Two methods of excitation, both using a directional coupler, are described. A general theory of the traveling-wave resonator in the absence of an electron beam is given. The important parameters for interaction with an electron beam are derived. Measurements on an experimental cavity agree well with theory. A discussion is given of the effects of electron beams on the field distribution in the cavity. The beam-coupling coefficient and the beam-loading admittance under small-signal conditions were calculated and presented in graphical form. The stability of operation of a klystron using traveling-wave cavities is compared with 1 using standing-wave cavities. A number of numerical examples for a connected-ring structure as the beam-interaction line were worked out and are presented in tabular form. These examples are given for a proposed multicavity klystron operating at an RF power level of about 1 megawatt. The results indicate that the proposed amplifier has a larger bandwidth for substantially the same gain than conventional klystrons.

2009

Stanford U. Microwave Lab., Calif.

THE THEORY OF THE SINUOUS WAVEGUIDE BEAM-COUPLER FOR MILLIMETER WAVE GENERATION, by A. L. Cullen. [1959] [15]p. (ML rept. no. 633) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22548) AD 228207 Unclassified

The theory of the sinuous waveguide beam-coupler is developed without recourse to the theory of relativity. The analysis is based on the idea that the sinuous waveguide can be regarded as a slow-wave structure capable of supporting space harmonics with phase constants $\beta + 2\pi n/\lambda$. The zero-order mode $n = 0$ and the condition for synchronous interaction is $\beta_e = \beta$, where $\beta_e = \omega/u_0$, and β differs from β' for the straight guide because of the increased path length along the sinuous axis. The 1st-order mode is $n = 1$ and $\beta_e = \beta + 2\pi/\lambda$, and the 2nd-order mode, $n = 2$ and $\beta_e = \beta + 4\pi/\lambda$. The characteristics of these various modes of interaction are discussed, and formulae for power output are given. Higher-order interactions are not investigated, as they are likely to be very inefficient. (Contractor's abstract)

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2010

Stanford U. [Radio Propagation Lab.] Calif.

PARIS SYMPOSIUM ON RADIO ASTRONOMY, Cité Universitaire (France) (July 30-Aug. 6, 1958), ed. by R. N. Bracewell. Stanford, University Press, 1959, 612p. incl. illus. diagrs. tables, refs. (ISRU: Symposium no. 1; IAU: Symposium no. 9) (AFOSR-4512) (AF 18(603)-53) Unclassified

The book consists of the research results reported at the symposium as subsequently submitted with the benefit of revision; and together with the several introductory surveys, discussions, and the concluding assessments. It provides a comprehensive account of the current state of development of the basic aspects of radio astronomy. The 6 organizers and sponsors of this symposium are briefly described. The major topics are as follows: Radio emission and reflections from planets, comets and the moon; solar radio emission and the quiet and active sun; radio study of individual objects (external to solar system); radio evidence on the large-scale structure of our own and external galaxies; source surveys, identifications, and other studies related to cosmological problems; and theory, mechanism of solar and cosmic radio emission. An author index is given for the 500 papers cited.

2011

Stanford U. Radio Propagation Lab., Calif.

INTERFEROMETER PHASING PROBLEMS AT MICROWAVE FREQUENCIES, by G. Swarup and K. S. Yang. [1959] [8]p. incl. diagrs. (AF 18(603)53) Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Published in I.R.E. WESCON Convention Record, Pt. 1, p. 17-24, 1959.

The electric field distribution required to realize a desired radiation pattern is sometimes quickly visualized by means of a transfer function (the spectral sensitivity function) which measures the response of the antenna system to the spatial frequencies of a 2-dimensional distribution of brightness. The effects of amplitude and phase errors of individual elements on the directivity and side radiation pattern of an interferometer system are discussed. In the case of phase-switched interferometers it is also important to evaluate the effect of fixed phase error of the switch and feeder system, and phase throw error of the switch, on the radiation pattern. It is shown that these phase errors affect the shape of the radiation pattern only if there exists an odd component in the 2-dimensional electric field distribution over an aperture. Details of construction of the transmission line system of a cross-antenna built at Stanford for operation at 9 cm wavelength are described. The antenna has 16 paraboloidal

reflectors in each arm of the cross and provides a pencil beam of nearly 4 min of arc width. The experimental technique employed in adjusting amplitude and phase of the field, impressed on each element of the interferometer is also described.

2012

Stanford U. [Stanford Electronics Labs.] Calif.

SOME PROPERTIES OF LIGHTNING IMPULSES WHICH PRODUCE WHISTLERS, by R. A. Helliwell, A. G. Jean, and W. L. Taylor. [1958] [3]p. incl. diagrs. (AF 18(603)-126) Unclassified

Published in Proc. Inst. Radio Engineers, v. 46: 1760-1762, Oct. 1958.

Conclusions drawn from the result of simultaneous observations of storms at Boulder and at Stanford are given. (1) It is found that a characteristic waveform is often associated with the impulse that produces a whistler. It possesses an intense energy peak near 5 kc/s and occurs infrequently compared with other atmospherics. (2) Whistler-producing discharges are most frequent over sea than over land. (3) The time of the origin of a whistler should not be calculated from the Eckersley dispersion law. Identification of the causative impulse should be based on waveform analysis as well as the time of occurrence.

2013

Stanford U. Stanford Electronics Labs., Calif.

TRAVELING-WAVE AMPLIFICATION IN THE IONOSPHERE, by T. F. Bell and R. A. Helliwell. Sept. 15, 1959, 8p. incl. diagrs. (Technical rept. no. 2) (AFOSR-TN-59-1099) (AF 18(600)126) AD 229793; PB 145321 Unclassified

A traveling-wave type of amplification of electromagnetic waves propagating in the "whistler-mode" is presumed to exist in the ionosphere. Streams of electrons moving down the earth's magnetic field lines can enter ionospheric regions in which the stream-velocity spectrum matches approximately the phase velocity of "whistler-mode" waves in that region. Under these conditions amplification of the wave may occur. This paper deals with the investigation of an analogous, but simplified, situation: a plasma, consisting of a uniform distribution of electrons and positive ions, exists in an extensive zero-temperature region well removed from boundaries. This plasma is permeated by a uniform and static magnetic field and also by a second plasma which moves with some constant velocity parallel to the magnetic field lines. In addition, a plane wave is assumed to be propagating through the composite medium, which is considered to be electrically neutral. For the above model, the modes of propagation of the wave are obtained, and the conditions necessary for wave amplification are studied. Application

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is made to conditions existing in the ionosphere and the consequent implications of the theory are discussed. (Contractor's abstract)

2014

Stanford U. [Stanford Electronics Labs.] Calif.

HYBRID WHISTLERS (Abstract), by R. A. Helliwell. [1959] [1]p. (AF 18(603)126) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 4-7, 1959.

Published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 287, July 1959.

Whistlers frequently exhibit many well-defined components which are thought to result from the existence of separate paths of propagation. It has been suggested that such paths might be defined by columns of enhanced ionization which are aligned with the earth's magnetic field and which reach from one hemisphere to the other. Another possibility is that whistler energy is permitted to emerge from the ionosphere only at specific locations where conditions are favorable. A test to differentiate these 2 models would be to excite whistler paths simultaneously in opposite hemispheres from the same source. At a receiver in either hemisphere the result would be the superposition of long and short whistlers—a hybrid whistler. The dispersion ratios of a hybrid whistler and its echoes would be 1:2:3:4:5, etc., if the paths were the same for both directions of propagation. A search of records from the IGY Whistlers-West project has revealed several examples of what appear to be genuine hybrids. Their existence argues strongly for the field-aligned column hypothesis of whistler paths.

2015

Stanford U. [Stanford Electronics Labs.] Calif.

THE TRAPPING OF WHISTLERS BY COLUMNAR IRREGULARITIES IN THE OUTER IONOSPHERE (Abstract), by R. L. Smith, R. A. Helliwell, and I. Yarbrough. [1959] [2]p. (AF 18(603)126) Unclassified

Presented at IRE-URSI Symposium, Washington, D. C., May 4-7, 1959.

Published in I.R.E. Trans. on Antennas and Propagation, v. AP-7: 287-288, July 1959.

Storey showed that whistlers should follow approximately the lines of force of the earth's field because of the anisotropy of the ionized medium. It has been suggested that columns or shells of enhanced ionization aligned with the earth's field might effectively trap the waves as in a waveguide. The conditions for such trapping are developed, assuming that ray theory applies and that the refractive index is large. It is found that waves

can be trapped not only in enhanced columns but also in columns of reduced ionization. The conditions for trapping are given in terms of the ratio of wave frequency to gyro-frequency, the initial wave normal angle, and the degree of enhancement. As an example, a 10 kc ray path is computed for a column with 20% enhancement of ionization with respect to the background level. The path exhibits small snakelike excursions from the axis of the column and satisfies the criteria which have been developed. Applications of this theory to the interpretation of whistler data are discussed.

2016

Stanford U. [Stanford Electronics Labs.] Calif.

OBLIQUE ECHOES FROM OVER-DENSE METEOR TRAILS, by L. A. Manning. Feb. 28, 1958, 20p. incl. diags. (Technical rept. no. 29) (Sponsored jointly by Air Force [Office of Scientific Research] Office of Naval Research, and Signal Corps under Nonr-22524) Unclassified

Also published in Jour. Atm. and Terrest. Phys., v. 14: 82-93, Apr. 1959.

For abstract see item no. STA.06:041, Vol. II.

2017

Stanford U. Stanford Electronics Labs., Calif.

AN INVESTIGATION OF THE MAGNETRON AMPLIFIER, by B. A. Wightman. Feb. 9, 1959, 87p. incl. illus. table. (Technical rept. no. 52) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 211869 Unclassified

The magnetron amplifier is investigated on account of its promise of efficiencies in excess of > 50%. (1) An analytical investigation of the interaction at small signal levels, and (2) an experimental effort to adapt the zig-zag line for the higher power requirements in the amplifier are studied. The model for the space-charge-wave interaction postulated by Heffner and Unotoro is inserted into the Pierce analysis of the amplifier. The result includes a determinantal equation for the space-charge-wave interaction which is the same as Gould's, but the analysis embraces all interactions, which are examined with respect to the energy exchange between beam and circuit in order to determine which interactions are useful. Some new and different conclusions are drawn. The selection of a slow-wave circuit for the amplifier is discussed, and the zig-zag line is chosen for its low dispersion. This circuit was adapted for higher powers by mounting on a ceramic of high thermal conductivity which was undercut to minimize dielectric loading. The circuit was successfully fabricated by an impact-grinding technique, and the thermal capacity was satisfactory. However, the effect of the undercutting was not as great as anticipated;

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the coupling impedance was reduced and the attenuation increased excessively. This circuit had an efficiency of 12%. Some alternative proposals for a circuit was made. (Contractor's abstract)

2018

Stanford U. Stanford Electronics Labs., Calif.

PHYSICAL PRINCIPLES OF AVALANCHE TRANSISTOR PULSE CIRCUITS, by D. J. Hamilton, J. K. Gibbons, and W. Shockley. Feb. 17, 1959, 19p. incl. diagrs. tables. (Technical rept. no. 53) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 213153 Unclassified

Also published in Proc. Inst. Radio Engineers, v. 47: 1102-1108, June, 1959.

A simple physical theory is developed which permits a calculation of the significant points of avalanche transistor transient behavior. A model for the transistor is defined in terms of charge variables and the physical parameters of the device. The transient performance of the model is calculated by focusing attention on the minority carrier charge stored in the base region and the influence of base-width modulation upon this stored charge. In the charge formulation of the problem, the physical details of the avalanche multiplication process need not be considered; multiplication is accounted for by the boundary conditions which it imposes upon the stored charge. Good agreement has been obtained between calculated and experimentally observed data for a simple avalanche transistor relaxation oscillator. (Contractor's abstract)

2019

Stanford U. Stanford Electronics Labs., Calif.

A CLASS OF MULTIPLE-ERROR-CORRECTING BINARY CODES FOR NON-INDEPENDENT ERRORS, by P. Fire. Apr. 24, 1959, 47p. incl. illus. tables. (Technical rept. no. 55) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 219307 Unclassified

In many data transmission and processing systems, the occurrence of multiple errors within a word is known to be a nonindependent phenomenon, i.e., the probability of an error occurring in a particular binary digit (binit) of the word is conditional on whether any errors occurred in some number of preceding binit. A class of parity-check error-correcting codes, specifically designed to cope with this situation, is described. These codes have the peculiar property that the check word derived in the normal decoding process is composed of 2 subwords, one defining the errors' pattern and the other indicating the error pattern's location within the word. The corrupted word is corrected merely by ad-

ding the shifted error-pattern subword to the indicated incorrect portion of the received word. A particular code of the proposed class may be designed in a straight forward manner to correct any number of information binit for any error pattern up to some specific maximum binit with, r . For example, a code for which r is equal to 3 will correct any one of the following: single error, double-adjacent error, 3-binit-wide double error, and triple-adjacent error. The codes may be instrumented simply by the use of a pair of linear feedback shift registers which generate the decoding table. Since shift-register feedback logic is fixed for a given code, table-lookup methods are not required for automatic decoding. Furthermore, since the codes afford a significant saving of parity binit, compared to codes correcting an equivalent number of independent errors, instrumentation is further simplified. The detection of error patterns including more than r errors is possible for those cases where the error-pattern width is no greater than the number of binit in the error-pattern subword. This is done merely by determining the number of ones in the error-pattern subword. (Contractor's abstract)

2020

Stanford U. Stanford Electronics Labs., Calif.

A THEORY FOR THE TRANSIENT ANALYSIS OF AVALANCHE TRANSISTOR PULSE CIRCUITS, by D. J. Hamilton. June 15, 1959, 62p. incl. illus. tables, refs. (Technical rept. no. 1701-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 218575; AD 230700 Unclassified

A simple physical theory is developed which describes the transient behavior of an avalanche transistor in terms of its physical parameters. The consideration of the minority carrier charge stored in the base during the transient process is an important factor in this development, and major emphasis is placed upon the use of charge variables in describing the model for the transistor. The theory is applied in the analysis of 2 classes of avalanche transistor pulse circuits: that in which the transistor is used with a capacitive load, or with a resistive load. Regardless of the load type used, a certain minimum value of avalanche multiplication must exist in the transistor if a regenerative build-up of current is to occur. It is shown that a rapid build-up rate requires a large multiplication value, and a theoretical limit of the maximum value can be derived from thermal considerations. With a capacitive load, the theory is used to obtain the critical values of load capacitance, the peak value of the current, an estimation of the rise time of the current pulse, and the effects of a small resistance in series with the capacitor. With resistive load, the theory is used to determine the current as a function of time. The validity of the theory is verified by the good agreement between the calculated and measured data. A more significant contribution of the theory, however, is the understanding which it conveys of the important factors that govern the behavior of avalanche transistors. (Contractor's abstract, modified)

2021

Stanford U. Stanford Electronics Labs., Calif.

THEORETICAL LIMITATIONS ON THE GAIN-BANDWIDTH PRODUCT OF THREE-TERMINAL NETWORKS, by J. J. Spilker, Jr. [1959] [5]p. incl. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-22524]) Unclassified

Published in I.R.E. Trans. on Circuit Theory, v. CT-6: 224-228, June 1959.

Wherever parasitic impedances are found shunting the terminals of a network, certain limitations on the electrical behavior of this network can be found. Typically, these parasitic impedances might represent a transistor, vacuum tube, or some other loading effect. Theoretical limitations are derived for the gain-bandwidth product of passive linear 3-terminal networks (not necessarily lossless) used as low-pass filters. An important use of these limitations is in determining the upper bounds on the performance of video amplifiers. Bode has considered limitations of this type for an important but restricted class of networks where the parasitic elements are purely capacitive, whereas, limitations are shown here for arbitrarily parasitic impedances. One important application of this new generality is that limitations can now be established for transistor amplifiers. This development has required the use of a general resistance integral theorem, the derivation of which is given. Different limitations are indicated for RLC networks and those allowing mutual inductance. Examples are given.

2022

Stanford U. Stanford Electronics Labs., Calif.

A STUDY OF THE EMITTING-SOLE LINEAR MAGNETRON AMPLIFIER, by D. Chen. July 14, 1959, 109p. incl. illus. tables. (Technical rept. no. 207-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 220571 Unclassified

A thick non re-entrant beam under Brillouin flow conditions, with the lower beam boundary in contact with the sole is explored. The analytical part of this study is to extend Buneman's small-signal theory of magnetrons to the case of the emitting-sole amplifier. The transverse normalized acceptance of the beam, R_b , at the upper beam boundary is derived. Computations of the complex R_b as a function of the complex propagation constant, in the region of interest, for 3 typical frequencies are given. Four asymptotic forms of R_b to cover the entire complex plane of the propagation constant are derived. The use of these asymptotic forms of R_b simplifies the procedure of susceptance matching between the beam and the circuit: from tedious graph-

ical method to the obtaining of the solutions of 4 algebraic equations. The wave solutions for matching the emitting-sole beam to free space and also to a conducting plate at 3 different distances above the beam are computed in detail through the use of these 4 asymptotic forms of R_b . Some discussions regarding the matching

of the emitting-sole beam to a periodic circuit are also given. A method of calculating the dc equilibrium position of a general thick beam in crossed-field, under Brillouin flow conditions, has been given. The electronic efficiency of a re-entrant-type emitting-sole beam is also estimated and compared to that of a thin beam. An experimental amplifier is designed and constructed. It employed a smooth conducting plate as a circuit, facing an emitting-sole beam which fills up 3/4 of the spacing between the circuit and the sole. Results on the dc beam transmission test are fairly satisfactory. However, the measurements on the r-f amplification suffer a serious drawback from the excessive beam noise whenever the cathode emission is under space-charge-limited conditions. Measurements taken with the cathode operated under temperature-limited conditions give a rate of gain of 1.1 db/cm. This compares fairly closely with the theoretical predicted value of 1.4 db/cm, where space-charge-limited emission is assumed. (Contractor's abstract)

2023

Stanford U. Stanford Electronics Labs., Calif.

DESIGN OF A SAMPLED DATA CONTROLLER USING TRANSISTOR LOGIC, by M. Cavestany. Aug. 13, 1959, 46p. incl. illus. (Technical rept. no. 2100-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 225011 Unclassified

The design and construction of a digital controller for use in the study of sampled-data control systems are described in detail. The device is a hybrid computer combining digital and analog techniques to take advantage of the special properties of each. A novel feature of this controller is the use of special modulators to convert the analog voltages to frequency information which is the form in which the data is stored on a magnetic drum. Section I, gives an exposition of the principles of digital compensation in sampled-data systems. The different steps leading to the conception and utilization of a digital controller are covered. Section II, presents a brief description of the present system, which is based on the utilization of a magnetic drum as data hold, storage, and delay element, with transistor digital logic circuits to perform the necessary switching. The last section gives the design of the switching block. It is concluded that since all the system is strongly dependent upon the characteristics of the drum, the range of utilization of this controller is perfectly defined. (Contractor's abstract, modified)

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2024

Stanford U. [Stanford Electronics Labs.] Calif.

CIRCUIT CONSIDERATIONS IN TRAVELING-WAVE PARAMETRIC AMPLIFIERS, by C. Bell and G. Wade. [1959] [8]p. incl. illus. diagrs. (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under [Nonr-22524]) Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Published in I.R.E. WESCON Convention Record, Pt. 2, p. 75-82, 1959.

Circuit considerations appropriate to wide-band operation in a traveling-wave parametric amplifier are described. The model analyzed is a transmission line periodically loaded with parametric diodes. The diodes constitute the variable elements. Across each diode is fed a large pumping voltage which produces a time-varying capacitance. A Brillouin diagram for the structure (i.e. a plot of ω vs β) can be computed from the analysis. The conditions for high gain, wide band, and other desirable characteristics are conveniently determined from this diagram. (Contractor's abstract, modified)

2025

Stanford U. Stanford Electronics Labs., Calif.

VARIABLE CAPACITANCE WITH LARGE CAPACITY CHANGE, by J. L. Moll. [1959] [5]p. incl. diagrs. (Sponsored jointly by Air Force [Office of Scientific Research], Office of Naval Research, and Signal Corps under Nonr-22524) Unclassified

Presented at Western Electronic Show and Convention, San Francisco, Calif., Aug. 18-21, 1959.

Published in I.R.E. WESCON Convention Record, Pt. 3: 32-36, 1959.

The capacitor described is an improved version of the Si crystal diode which utilizes the variation in barrier thickness with voltage to achieve a voltage-controlled capacitance. In the present construction a thin film of oxide is created on the surface of n-type Si and a small counterelectrode evaporated on to the oxide. As a result, a higher capacitance is achieved at low voltage while the capacitance at high reverse voltages is unchanged. The range is thus increased.

2026

Stanford U. Stanford Electronics Labs., Calif.

ALUMINO-SILICATE GLASS-TO-MOLYBDENUM-DISC SEAL, by J. F. Margiotta. Sept. 1, 1959, 5p. incl.

illus. (Bull. no. 102) ([Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under] Nonr-22524) AD 225955

Unclassified

A description is presented of the preparation of a Mo-glass seal for a TWT envelope. Corning no. 1720 glass tubing was cut to size with a conventional water-cooled cut-off wheel; the ends were hand-ground on a glass plate, immersed in 49% CP-grade HF for 5 sec, and rinsed successively in tap H_2O , distilled H_2O , acetone, distilled H_2O , and EtOH. The Mo disks were given a high polish with extra-fine rubberized abrasive, degreased and rinsed, and fired at 900°C in wet H for 15 min. The surface to be sealed was deplated in a weak H_2CrO_4 - H_2SO_4 solution and the part was rinsed in the same manner as was the glass tube. The Mo piece was oxidized by heating with an RF concentrator in air for 3 min at 550°C to form a yellowish-white MoO_3 coating, then heated in a bell jar with a He atmosphere at increasing temperatures up to 1000°C until the MoO_3 disappeared. The glass was jigged into place, the bell jar was refilled with He, and the temperature was raised to 1000°C (brightness) where the glass began to soften. The temperature was increased to 1200°C and held there for 2 or 3 min until the Mo disk dropped into place and the seal was completed. The assembly was allowed to cool, then placed in an annealing oven idling at 450°C with either at 75% N-25% H or a N atmosphere. The atmosphere was switched to line H; the temperature was raised to the annealing point of the glass (715°C), held for 15 min, then allowed to drop to room temperature in 1½ hr.

2027

Stanford U. Stanford Electronics Labs., Calif.

CERAMIC METALIZING MIXES, by R. Keller. Sept. 1, 1959, 2p. (Bull. no. 101) (Sponsored jointly by Air Force of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 234514

Unclassified

Two metalizing mixes are used to make satisfactory ceramic-to-metal seals. One is the Stanford Microwave Lab. mix no. 2A used in the large klystrons for the linear acceleratory. It is composed of the following: Mo, Mn and Fe powders; SiO_2 , CaO, nitrocellulose mix, acetone, methyl ethyl ketone and Cellosolve. The nitrocellulose mix contains nitrocellulose, toluene, methyl ethyl ketone, and ethyl acetate. Mix no. 101 requires less critical control of temperature and atmosphere. However, there are indications that this mix deteriorates on standing. It is composed of the following Mo, Mn, Fe, alumina powders; SiO_2 ; titanium hydride; and nitrocellulose mix.

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Stanford U. Stanford Electronics Labs., Calif.

A MODIFIED FORM OF THE MELLIN TRANSFORM AND ITS APPLICATION TO THE OPTIMUM FINAL VALUE CONTROL PROBLEM, by J. Pashon. Nov. 3, 1959, 146p. incl. illus. tables. (Technical rept. no. 2102-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 229111 Unclassified

The class of systems investigated is characterized by the requirement that all the plant (the device to be controlled) states (the output and output derivatives) assume a prescribed value at some normalized time 'one'. The linear, time-varying systems investigated have the property of moving the plant to the desired final state in spite of most disturbances and parameter changes. A modified form of the Mellin Transform provides a convenient tool to analyze and synthesize such final-value systems; this transform is applied to time-varying systems in a manner quite similar to the Laplace Transform in linear constant-coefficient systems. In addition to the final-value requirement, it is often desired to make the plant output follow a trajectory which is optimum in some sense. If this optimum trajectory is described by a linear differential equation, such as an Euler equation, the modified form of the Mellin Transform can be used to synthesize a control-system in which the plant output approximately follows this optimum trajectory, regardless of the values of the given initial and the desired final states. (Contractor's abstract)

2029

Stanford U. Stanford Electronics Labs., Calif.

SERIES SOLUTIONS FOR PERTURBATIONS ON CROSSED-FIELD BEAMS, by B. A. Wightman and D. Chen. Nov. 9, 1959, 19p. incl. illus. table. (Technical rept. no. 207-2) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 229950 Unclassified

The differential equation of perturbations on the Brillouin state of a rectilinear beam in crossed fields is presented. The solutions of this differential equation have limited value for computational purposes. Series developments are given of these solutions, and the numerical values of the coefficients are tabulated in a form adapted to high-speed digital computation. The same information is given for a determinantal function formed from these solutions and applicable to boundary-value problems involving such a beam. An example problem is solved using this determinantal function. (Contractor's abstract)

2030

Stanford U. Stanford Electronics Labs., Calif.

STUDY OF SEMICONDUCTOR DEVICES BY ANALOGUE TECHNIQUES, by R. Bharat. Nov. 16, 1959, 83p. incl. illus. refs. (Technical rept. no. 1502-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 229532 Unclassified

Analogue techniques are applied to the study of semiconductor devices in pulse circuits, enabling one to make a transient analysis of models which describe both the internal and the terminal behavior of the devices. Physical phenomena in semiconductor devices are described in terms of lumped models and an analogue computer is set up to simulate the equations derived from these models. Equations relating the variables in the model of the device to the variables describing the circuit in which the device is operating are also simulated on the computer, and transient solutions are obtained for all the variables. Computer and electric-circuit analogues of several physical phenomena frequently encountered in semiconductor devices are developed. Both linear and nonlinear phenomena are considered and various methods of simulating them are described. Analogue computer solutions are obtained for transistor pulse circuits in which interacting nonlinear phenomena influence the operation of the circuit. Solutions for a drift-transistor switching circuit and for an avalanche-transistor relaxation-oscillator circuit are presented. (Contractor's abstract in part)

2031

Stanford U. Stanford Electronics Labs., Calif.

INVESTIGATIONS OF THE HELITRON OSCILLATOR, by B. P. Israelsen. Nov. 23, 1959, 205p. incl. illus. (Technical rept. no. 404-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 232289 Unclassified

Investigations, aimed at providing a better understanding of the helitron, are described. The feasibility of the 1st experimental model, built in 1956, is discussed with respect to operating characteristics: (1) spurious oscillations, and (2) ripples in the backward-wave gain vs frequency curve when operated as an amplifier. The results of (1) indicated that the variation of the spurious level with collector current, interaction length, and anode voltage showed possible existence of a coaxial mode between circuit and sole, the influence of trajectory perturbations, and the effect of beam collector configuration. As for (2), the gain measurements pointed to a relation between the multiply-peaked gain curve and spurious oscillation modes. A 2nd experimental helitron was constructed, the r-f circuit consisted of 2 rather than 4 segments with an internal termination. The beam was injected from a slalom focusing structure, in contrast to the 1st experimental tube

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which used a snout-like extension of the anode. Performance was not as good as obtained with the 1st helitron, due to limitations in the mechanism of slalom injection. A small-signal field theory based on expansion in normal modes is presented. This theory shows that azimuthal beam bunching (in the direction of electron motion) is the primary interaction mechanism. Thus the helitron behaves as an O-type device. A study of space charge effects indicates that 1 of the 2 space charge waves grows exponentially, even in the absence of circuit fields. An equation for backward-wave gain is given in which 2 circuit waves and 2 beam waves are considered. Numerical evaluation of this equation shows that interference between the backward circuit wave and the growing space charge wave produces the observed gain ripple. Theoretical starting current is within a factor of 2 of the measured value. (Contractor's abstract, modified)

2032

Stanford U. Stanford Electronics Labs., Calif.

THE ANALYSIS AND SYNTHESIS OF NONLINEAR CONTINUOUS AND SAMPLED-DATA SYSTEMS INVOLVING SATURATION, by F. Kurzwel, Jr. Nov. 30, 1959, 97p. incl. illus. refs. (Technical rept. 2101-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 231411 Unclassified

The saturating systems studied are either continuous or discrete. Initially, they are broken into classes in which the representative member is the physical plant in Jordan normal form. The equations describing the plant are written in terms of its impulse response matrix $G(t)$ and the forcing function $m(t)$. The constraint on the forcing function, $|m(t)| < 1$, categorizes the system as a saturating system. The optimum saturating system is defined to be that system which returns to equilibrium in minimum time subject to the constraint on the forcing function, and from theoretical consideration, it is a system that requires the maximum of the forcing function be applied at all times. The synthesis problem is that of construction of the optimum switching surfaces in n -dimensional space. The method proposed here consists in the construction of a linear region by means of a subspace generator, then the placement of the point $x(0)$ on a boundary of the linear region. Analysis in the sampled-data realm is considerably simpler than in the continuous case since a given sampling period T automatically fixes the lag-time between the physical plant and the tracking subspace generator and places bounds on the quantity $(Dev)_{opt}$. As T is decreased, the system approaches the optimum continuous system. (Contractor's abstract)

2033

Stanford U. Stanford Electronics Labs., Calif.

A METHOD FOR SOLUTION OF NONLINEAR NET-

WORK PROBLEMS BY DIGITAL COMPUTERS, by W. F. Gillmore, Jr., Dec. 30, 1959, 171p. incl. tables, refs. (Technical rept. no. 2051-1) (Sponsored jointly by Air Force Office of Scientific Research, Office of Naval Research, and Signal Corps under Nonr-22524) AD 233022 Unclassified

This study is concerned primarily with a special 'Taylor' approximation method. Contents can be outlined as follows: (1) The evolution of the approximation method: Prony's method; Tuttle's method; and alternate procedures. (2) Calculation by continued fractions: expansion of a series in a continued fraction; converting fractions to ordinary fractions; simple approximations; a complete table of approximations; and questions of convergence. (3) Relation to Hilbert space theory; two special continued fractions; a related linear operator; eigenfunctions of the linear operator; and inversion of the Stieltjes transform. (4) Approximate solution of nonlinear differential equations; nature of the approximation; and calculation of the initial derivatives. (5) Other applications and examples: digital computer programming; network synthesis from time response, analog computer function generators; and approximations from discrete data.

2034

Stevens Inst. of Tech. Dept. of Physics, Hoboken, N. J.

PLASMA MOTORS: THE PROPULSION OF PLASMA BY MAGNETIC MEANS, by W. H. Bostick. [1958] [15]p. incl. illus. diagrs. refs. (AFOSR-1653) [AF 49(638)-156] AD 265302 Unclassified

Published in Proc. Ninth Internat'l. Astronaut. Congress, Amsterdam (Netherlands) (Aug. 25-30, 1958), Vienna, Springer-Verlag, v. 2: 794-803, 1959.

It has been experimentally demonstrated that speeds of the order of 10^7 cm/sec can be obtained by the propulsion of plasmas by magnetic forces resulting from high electrical current passed through the plasma. In order to increase the efficiency of energy transfer from the capacitor in which the energy is stored to the kinetic energy of the plasma, it is desirable that the gun be spread out over a distance of a large fraction of a meter in order that a discharged current can act upon the plasma for an appreciable length of time. This report examines the relationships for energy transfer in various types of rail-type plasma guns and motors. Also discussed is the efficiency of energy transfer in the induction or electrodeless type of gun. It is shown that with the rail-type guns with a length of the order of a meter with currents of the order of 10^4 amp and externally excited fields of the order of 10,000 gauss, speeds of the order of 10^8 cm/sec and a back emf of the order of 20 kv can be expected. This high a back emf suggests that it is possible to extract most of the energy of the capacitor and transform it into kinetic energy of the plasma in the first half cycle of current. (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

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Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

EXPERIMENTAL STUDIES ON PLASMA DYNAMICS, by W. H. Bostick, J. Nankivell and others. [1959] [9]p. incl. illus. diagrs. (AFOSR-1654) (Sponsored jointly by Air Force Cambridge Research Center, Air Force Office of Scientific Research under [AF 49(638)156], Atomic Energy Commission, and Republic Aviation Corp.) AD 265302 Unclassified

Also published in Proc. Third Biennial Gas Dynamics Symposium on Dynamics of Conducting Gases, Evanston, Ill. (Aug. 24-26, 1959), Evanston, Northwestern U. Press, 1960, p. 107-111. (AFOSR-TR-60-87)

The mechanics of the extraction of electrical power from a moving plasma can be studied by using two parallel plates between which the plasma can be projected across a magnetic field. This electromagnetic brake can then be used to measure the internal resistance of the plasma between these plates. Once the internal resistance has been measured, it is then possible to determine the plasma density from the measured RC decay time. Two limited area probes utilizing the electric field as the driving potential may be used to measure the saturated ion current. Also, two probes may be used to measure the Hall electric field. Experimental verification of the above techniques has been made and, although additional refinement is necessary, the experimental results agree with calculated values within an order of magnitude consideration.

2036

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

ACCELERATION OF A PLASMA BY MEANS OF A RAIL TYPE GUN (Abstract), by G. Schmidt, W. H. Bostick and others. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)156], Atomic Energy Commission, and General Electric Co.) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 236, Apr. 30, 1959.

The principle and operation of a rail type plasma gun is described. An electric discharge ionizes the gas in the gun while the em field of the discharge circuit accelerates this plasma along the rails projecting it into a high vacuum region. Velocity and momentum measurements are made in this region with time-of-flight between two probes for the velocity and a ballistic pendulum measurement for the momentum. High plasma speeds are observed. Some possible applications of fast plasmas are discussed.

2037

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

EXPERIMENTAL STUDIES ON PLASMA DYNAMICS (Abstract), by S. Koslov, W. H. Bostick and others. [1959] [1]p. (Sponsored jointly by Air Force Cambridge Research Center, Air Force Office of Scientific Research under [AF 49(638)156], Atomic Energy Commission, and Republic Aviation Corp.) Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 236, Apr. 30, 1959.

A new technique for measuring the mass of a plasmoid projected across a magnetic field employs an electromagnetic brake. Plasmoid masses of the order of 10^{-9} g can readily be measured. The electromagnetic brake places the plasmoid in a decelerated frame of reference. A bipolar probe technique has been developed for measuring not only the electric field associated with the Lorentz transformation but the electric field due to the decelerated frame of reference. The bipolar probe technique can also be used to measure ion densities over small volumes, and can be used to verify previous measurements which indicated that under some conditions hollow plasmoids can be produced. Measurements with this technique indicate that hollow plasmoids do not spin. These results lay to rest the previous hypothesis that spin is responsible for the hollowness of plasmoids.

2038

Stevens Inst. of Tech. Dept. of Physics, Hoboken, N. J.

STATIONARY NONEQUILIBRIUM GIBBSIAN ENSEMBLES, by J. L. Lebowitz. [1959] [11]p. incl. refs. (AFOSR-TN-59-5) [AF 49(638)352] AD 208185 Unclassified

Also published in Phys. Rev., v. 114: 1192-1202, June 1, 1959.

The general theory of a Gibbs ensemble representing a system in contact with its surroundings is applied to several concrete situations of interest. By an appropriate choice of heat reservoirs a simply modified Liouville equation is found to describe a heat conducting system. The stationary nonequilibrium Γ -space ensembles which describe such a system are found explicitly for some cases. In the simplest cases these ensembles turn out to be canonical with a temperature that is a weighted average of the reservoir temperatures. For other systems, such as Brownian particles inside a fluid whose temperature is not uniform, the stationary ensemble to terms linear in the temperature gradient is found. Next, ensembles that will approximately represent an arbitrary heat conducting fluid are discussed.

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A more general proof than previously given for the asymptotic approach of the Γ -space distribution to its stationary value is also presented.

2039

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

STATISTICAL MECHANICS OF RIGID SPHERES, by H. Reiss, H. L. Frisch, and J. L. Lebowitz. [1959] [52]p. incl. diagrs. refs. (AFOSR-TN-59-140) (AF 49(638)352) AD 210864 Unclassified

Also published in Jour. Chem. Phys., v. 31: 369-380, Aug. 1959.

An equilibrium theory of rigid sphere fluids is developed based on the properties of a new distribution function $G(r)$ which measures the density of rigid sphere molecules in contact with a rigid sphere solute of arbitrary size. A number of exact relations which describe rather fully the functional form of $G(r)$ are derived. These are based on both geometrical considerations and the virial theorem. A knowledge of $G(a)$ where a is the diameter of a rigid sphere enables one to arrive at the equation of state. The resulting analytical expression which is exact up to the third virial coefficient gives the fourth virial coefficient within 2% and the fifth, insofar as it is known, within 5%. Furthermore over the entire range of fluid density, the equation of state derived from theory agrees with that computed using machine methods. Theory also gives an expression for the surface tension of a hard sphere fluid in contact with a perfectly repelling wall. The dependence of surface tension on curvature is also given. The expressions obtained correlate nicely with those adduced by other thermodynamic and statistical mechanical theories. It is also suggested that macroscopic consideration on surface tension can sometimes be successfully extrapolated to molecular dimensions.

2040

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

THE EQUATION OF STATE OF A FLUID, by J. L. Lebowitz, H. L. Frisch, and H. Reiss. [1959] [15]p. incl. diagrs. table. (AFOSR-TN-59-511) (AF 49(638)-352) AD 241256 Unclassified

Also published in Proc. Tenth Internat'l. Cong. of Refrig., Prog. in Refrig. Sci. and Tech., Copenhagen (Denmark) (Aug. 10-26, 1959), New York Pergamon Press, v. 1: 164-170, 1960.

The work required to form a cavity in a field is intimately related to its equation of state. This work is also related to the probability of finding such a cavity at equilibrium. For a fluid consisting of molecules possessing an impenetrable core this probability is known for sufficiently small cavities, while (in general) for sufficiently large cavities the work is essentially

given by a pressure-volume term. This and certain thermodynamic considerations suggest an approximate interpolation formula for the work to form a cavity of any size. For the case of a hard sphere fluid (no attractive forces) this yields a simple analytic equation of state in excellent agreement with that obtained empirically by machine computations and the virial expansion. When the attractive forces are not neglected one obtained from previous theory expressions for the surface tension, Henry's law solubility coefficient and the "high temperature" equation of state. These results agree reasonably well with experimental measurements on simple fluids. Extension of these relations to fluids at very low temperatures where quantum fluctuations play a decisive role are of great interest. While some of the previously derived relations require but small changes, others i.e., the relation between work and probability must be drastically modified. (Contractor's abstract)

2041

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

ASPECTS OF THE STATISTICAL THERMODYNAMICS OF REAL FLUIDS, by H. Reiss, H. L. Frisch and others. [1959] [6]p. incl. tables, refs. (AFOSR-TN-59-693) [AF 49(638)352] AD 241007 Unclassified

Also published in Jour. Chem. Phys., v. 32: 119-124, Jan. 1960.

By extending the ideas previously applied to the statistical mechanical theory of hard sphere fluids of Reiss, Frisch, and Lebowitz (Jour. Chem. Phys., v. 31: 363, 1959), an approximate expression has been determined for the work of creating a spherical cavity in a real fluid. In turn the knowledge of this entity permits an evaluation of properties such as the surface tension and the normal heats of vaporization of fluids and the Henry's law constants of fluid mixtures. The agreement between the calculated and experimental properties is satisfactory. (Contractor's abstract)

2042

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

[THEORETICAL RESEARCH IN THE STATISTICAL MECHANICS OF PHYSICAL PROCESSES], by J. L. Lebowitz. Final rept. June 15-Sept. 15, 1959 [21]p. incl. refs. (AFOSR-TR-59-150) (AF 49(638)352) AD 227146; PB 145714 Unclassified

The investigations reported in this final report lie in the broad field of statistical mechanics which concerns itself with the explanation of the observed properties of macroscopic matter in terms of the properties of its constituent molecules. Both the equilibrium and nonequilibrium processes are studied. It is reported that the area of nonequilibrium, unlike the equilibrium studies, has no adequate theory to

AIR FORCE SCIENTIFIC RESEARCH

help explain the phenomenon. It is impossible to predict even in principle all the properties of a metal rod, or a cylinder filled with liquid, 1 side of which is in contact with a steam bath and the other with an ice bath. Progress made in the efforts to develop a theory for such systems is also reported here.

2043

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

ASYMPTOTIC VALUE OF THE PAIR DISTRIBUTION FUNCTION AT A WALL (Abstract), by J. L. Lebowitz. [1959] [1]p. [AF 49(638)352] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 14, Jan. 28, 1959.

It is shown that the conditional probability density $p^w(r_2/r_1)$ finding a particle in the neighborhood of a point r_2 in the interior of a fluid when it is known that there is a particle at r_1 in contact with the rigid walls of the container, approaches the value $p - (\rho^2 kT/pN)$ for r_2 far from the wall. Here ρ is the number density at r_2 , p the pressure, and N the total number of particles in the box. This relation is to be contrasted with the well known Ornstein-Zernike expression for the asymptotic value of $p(r_2/r_1) = p(|r_2 - r_1|)$ when both r_1 and r_2 are in the interior of the fluid, $\lim_{r_{12} \rightarrow \infty} p(r_{12}) = \rho - \rho^2 (hT\chi_T/N)$, where χ_T is the isothermal compressibility. The derivation of the asymptotic value of $p^w(r_2/r_1)$ is based on the virial theorem for the fluctuations in the total momentum in an equilibrium ensemble. Since it appears that these fluctuations behave classically even for liquid helium II our considerations apply also to quantum systems.

2044

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

EQUATION OF STATE OF HARD SPHERE FLUIDS (Abstract), by H. Reiss, H. L. Frisch, and J. L. Lebowitz. [1960] [1]p. [AF 49(638)352] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 15, Jan. 28, 1959.

A set of relations has been discovered which deter-

mines to within a high degree of approximation the value of the radial distribution function for hard spheres in contact. In the case of hard spheres this one value, g , of the radial distribution function suffices to determine the equation of state and so the aforementioned relations yield the equation of state to the same degree of approximation. The principle relation is obtained by computing the pressure in two different ways and equating the results. First, the pressure is computed using the virial theorem leading to a relation containing g . Alternatively, the pressure can be computed in terms of an integral involving the radial distribution function G at contact for a normal hard sphere molecule around a hard sphere solute molecule of smaller size. The integral is over the radius r of the solute as it passes from zero to the size of the other hard spheres.

2045

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

BROWNIAN PARTICLES IN A NONUNIFORM FLUID (Abstract), by J. L. Lebowitz. [1959] [1]p. [AF 49(638)352] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 243, Apr. 30, 1959.

The time evolution of the distribution function for a Brownian particle in a fluid is described by the Fokker-Planck equation. When the temperature of the fluid is uniform this equation leads to the Brownian particle achieving a Maxwell-Boltzmann distribution asymptotically in time. We have now found the stationary distribution of the Brownian particles for the case when the temperature and pressure of the fluid are not uniform, to terms linear in the gradients. We can also show that this solution is approached asymptotically in time.

2046

Stevens Inst. of Tech. [Dept. of Physics] Hoboken, N. J.

STATISTICAL MECHANICS OF REAL FLUIDS (Abstract), by H. Reiss, H. L. Frisch, and J. L. Lebowitz. [1959] [1]p. [AF 49(638)352] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 243-244, Apr. 30, 1959.

The techniques applied by the authors to rigid spheres have been extended to the treatment of certain real substances (Ne, Ar, He, H₂, N₂, O₂, Cl₂, C₆H₆, and solutions of these) with good results. The surface tensions of these substances as well as the Henry's law

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constants for certain solutions of them have been calculated. In addition the equations of state of the more simple fluids are derived and compare well with experiment.

2047

[Sundstrand Machine Tool Co.] Sundstrand Turbo Div.
[Pacoima, Calif.]

SCALING PROCEDURES FOR ROCKETS UTILIZING LIQUID PROPELLANTS OF VARIABLE COMPOSITION AND MIXTURE RATIO, by S. S. Penner. Aug. 31, 1959, 18p. incl. table, refs. (Rept. no. S/TD 1733; technical note no. 7) (AFOSR-TN-59-908) (AF 18-603)107 AD 227923; PB 144012 Unclassified

Inherent contradictions in scaling requirements for liquid-fuel rocket engines are removed by introducing new degrees of freedom through controlled variations in mixture ratio, propellant type, or injection temperature. It is not possible to predict the dependence of effective conversion time on these parameters for the complex combustion processes in liquid-fuel rocket engines. However, examination of theoretical results derived for the overall (laminar) burning rate in 1-dimensional, dilute sprays suggests that relative propellant volatility and injector design, as well as total calorific values for the propellants, should dominate the effective dependence of conversion time on propellant type and mixture composition. A satisfactory quantitative evaluation of these ideas requires extensive empirical measurements of effective conversion time, preferably under conditions simulating rocket-engine combustion conditions. Representative simplified examples of scaling procedures have been worked out in which, for example, changes in mixture ratio must alter the effective conversion time by the square-root of the thrust scale factor. (ASTIA abstract)

2048

Sundstrand Machine Tool Co. Sundstrand Turbo Div.,
Pacoima, Calif.

FOURTH SYMPOSIUM ON COMBUSTION INSTABILITY IN LIQUID ROCKET MOTORS (Unclassified title), ed. by R. G. Langlois. Dec. 9-10, 1957, 197p. incl. illus. diagrs. tables, refs. (AFOSR-TR-59-51) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)107 and Bureau of Aeronautics) AD 307046 Confidential

2049

Syracuse U. Dept. of Chemistry, N. Y.

EFFECT OF TEMPERATURE ON CARBONYL AND NITRILE STRETCHING FREQUENCIES IN SOLUTION,

by E. Fishman and N. Krascella. July 1, 1959 [20]p. incl. diagrs. table, refs. (AFOSR-TN-59-660) (AF 49(638)3) AD 220725; PB 143169 Unclassified

Presented at meeting of Molecular Spectroscopy, Bologna (Italy), Sept. 12, 1959.

Efforts were made to separate empirically dipole-dipole interactions from other types of intermolecular forces responsible for frequency shifts. It was not possible to find simple relationships from these data which accomplish this. Graphs were prepared relating the frequency shift to the density and to the square of the density of the solvent; the resultant curves do not show consistent differences between polar and non-polar solvents. The results do show that $C \equiv N$ does have much smaller frequency shifts than $C = O$, indicating that the electric moment and the polarizability of a bond are not decisive factors. However, the derivatives of the bond moments and polarizabilities with respect to interatomic distance are much larger for $C = O$ than for $C \equiv N$, indicating that these may be more significant properties. In chloroform, nitrobenzene, benzene, CCl_4 and CH_3 acetonitrile's frequency shifts either not at all or slightly toward the blue with decreasing temperature, thought to be unique for lowering temperatures. It is interpreted that this blue shift results from repulsive electrical forces operating on the nitrile group when the entire molecule assumes its optimal orientation. Benzonitrile exhibits a blue shift equal to or slightly greater than that of acetonitrile in the 5 above solvents. In the alkyl polar halide solvents, the latter exhibits its strongest red shift, while the former undergoes a blue shift. These results may be due to changes in the nitrile bond when attached to an aromatic system, but they are consistent with the orientation hypothesis.

2050

[Syracuse U. Dept. of Mathematics, N. Y.]

ON A QUESTION OF PAUL LÉVY, by R. V. Chacon. [1959] [8]p. (AF 18(600)760) Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 460-465, June 1959.

A matrix $\{p_{ij}(t)\}$, $i, j = 1, 2, \dots$, $0 < t < \infty$, of functions is a (stationary) transition matrix (of a Markov chain) if (1) $p_{ij}(t) \geq 0$, $i, j = 1, 2, \dots$, (2) $\sum_r p_{ir}(t) = 1$, $i = 1, 2, \dots$, and (3) $\sum_r p_{ir}(t)p_{rj}(s) = p_{ij}(t+s)$, $i, j = 1, 2, \dots$, $0 < s < \infty$, $0 < t < \infty$. The question examined is whether each such transition function, which is not measurable, must be a transition function of a Markov chain obtained by combining a Markov chain having measurable transition functions with one having a transition matrix of nonmeasurable functions which takes only the values of zero or one. It is shown that if each of the transition functions is strictly positive or identically zero, then the equation

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$\lim_{t \rightarrow \infty} p_{ij}(t) = \lim_{t \rightarrow \infty} p_{ji}(t)$ or $p_{ji}(t) \equiv 0$, holds without measurable assumptions, and without assuming an affirmative answer to the question. The limiting behavior of the transition functions which would be expected if the question has an affirmative answer is described.

2051

Syracuse U. [Dept. of Mathematics] N. Y.

ON THE ANALYTIC STRUCTURE OF SEMI-GROUPS OF POSITIVE MATRICES, by W. B. Jurkat. Oct. 1959, 31p. incl. refs. (Research rept. no. 22) (AFOSR-TN-59-1263) (AF 49(638)265) AD 233135; PB 146731
Unclassified

Also published in Math. Zeitschr., v. 73: 346-365, 1960.

The dual of the first entrance formula is obtained from which general differentiability properties are deduced. (Contractor's abstract)

2052

Syracuse U. [Dept. of Mathematics] N. Y.

ON LAST EXIT TIMES, by K. L. Chung. Oct. 1959, 16p. (Research rept. no. 23) (AFOSR-TN-59-1264) (AF 49(638)265) AD 233092; PB 146730 Unclassified

Also published in Illinois Jour. Math., v. 4: 629-639, Dec. 1960.

The last exit time from a given state before a given time is studied. Its properties related to the analytic properties of the transition matrix and the reversed nonstationary chains are also discussed. (Contractor's abstract)

2053

[Syracuse U. Dept. of Mathematics, N. Y.]

THE DIFFERENTIABILITY OF TRANSITION FUNCTIONS, by D. Ornstein. [1959] 7p. [Research rept. no. 24] (AFOSR-TN-59-1265) (AF 49(638)265) AD 233105; PB 146732
Unclassified

Also published in Bull. Amer. Math. Soc., v. 66: 36-39, Jan. 1960.

A proof is presented that the transition functions of a denumerable Markoff chain are differentiable, or equivalently, given a matrix of real valued functions $P_{ij}(t)$ ($i, j = 1, 2, \dots$) satisfying (1) $P_{ij}(t)$ is non-negative and continuous; (2) $P_{ij}(0) = \begin{cases} 1 & \text{if } i = j, \text{ and} \\ 0 & \text{if } i \neq j; \end{cases}$

(3) $P_{ij}(t_1 + t_2) = \sum_{k=1}^{\infty} P_{ik}(t_1) P_{kj}(t_2)$; and (4) $\sum_{j=1}^{\infty} P_{ij}(t) = 1$.

Then $P_{ij}(t)$ has a finite continuous derivative for all $t > 0$. (Contractor's abstract)

2054

Syracuse U. [Dept. of Mathematics] N. Y.

ON THE ANALYTIC STRUCTURE OF MARKOV PROCESSES, by W. B. Jurkat. Oct. 1959, 5p. (Research rept. no. 25) (AFOSR-TN-59-1266) (AF 49(638)265) AD 233106; PB 146733
Unclassified

A general solution to the backward Kolmogorov equation is constructed under the hypothesis of a finite number of exits. (Contractor's abstract)

2055

Syracuse U. [Dept. of Mathematics] N. Y.

A GENERAL ERGODIC THEOREM, by R. V. Chacon and D. S. Ornstein. Oct. 1959, 11p. (Research rept. no. 26) (AFOSR-TN-59-1267) (AF 49(638)265) AD 233107; PB 146734
Unclassified

Also published in Illinois Jour. Math., v. 4: 153-160, June 1960.

The following theorem is proved: Let T be a positive linear operator on L_1 of a positive measure space (S, G, μ) and let T have L_1 norm less than or equal to one.

Then if t and p are functions in L_1 and if p is non-negative, the limit $\lim_{n \rightarrow \infty} \frac{\sum_{k=0}^n T^k t}{\sum_{k=0}^n T^k p}$ exists and is finite almost everywhere on the set $A = \{s: T^k p > 0 \text{ for some } k \geq 0\}$.

2056

Syracuse U. [Dept. of Mathematics] N. Y.

ON THE LIPSCHITZ'S CONDITION FOR BROWNIAN MOTION, by K. L. Chung, P. Erdős, and T. Sirao. [1959] [12]p. [AF 49(638)265]
Unclassified

Published in Jour. Math. Soc. Japan, v. 11: 263-274, Oct. 1959.

Let ψ throughout be a non-negative monotone, non-decreasing function on some (varying) interval (T, ∞) . ψ is said to belong to the "upper class" if, for almost every Brownian path $X(t)$ in $[0, 1]$, there exists $\epsilon > 0$ such that $|s-t| \leq \epsilon$ implies $|X(s)-X(t)| \leq \psi(|s-t|^{-1})$

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$|s-t|^{\frac{1}{2}}$. If, on the other hand, there is, for almost every Brownian path, no such ϵ , then ψ is said to belong to the "lower class". The following theorem has been stated without proof by P. Levy in his book *Le mouvement brownien*, and it is proved here. ψ is upper or lower, according as $\int_T^\infty \psi^3(t) \exp(-\frac{1}{2} \psi^2(t)) dt$ is finite or infinite. Then ψ is upper or lower according as $c > 2$ or $c \leq 2$. (Math. Rev. abstract)

2057

Syracuse U. [Dept. of Mathematics] N. Y.

POLYNOMIAL APPROXIMATION OF CONTINUOUS FUNCTIONS ON LINEAR SPACES, by W. B. Jurkat. Dec. 17, 1959, 10p. (AFOSR-TN-59-1235) (AF 49-(638)619) AD 231608; PB 145554 Unclassified

Also published in Math. Zeitschr., v. 74: 99-104, 1960.

A study is presented on the approximation of continuous functions on separable closed subsets of a Frechet space X by polynomials with coefficients in X. (Contractor's abstract)

2058

Syracuse U. [Dept. of Mathematics] N. Y.

RELATIONS BETWEEN FUNCTION SPACES, by G. G. Lorentz. Dec. 17, 1959, 7p. (AFOSR-TN-59-1286) (AF 49(638)619) AD 231609; PB 145505 Unclassified

Also published in Proc. Amer. Math. Soc., v. 12: 127-132, Feb. 1961.

Necessary and sufficient conditions are given, in terms of the functions ϕ and W, in order that an Orlicz space L_ϕ be isomorphic to a space $A(W)$. (Contractor's abstract)

2059

Syracuse U. [Dept. of Mathematics] N. Y.

ON UNIFORM APPROXIMATION BY POSITIVE LINEAR COMBINATIONS OR POLYNOMIALS OF A GIVEN SYSTEM OF FUNCTIONS, by W. B. Jurkat and G. G. Lorentz. Dec. 17, 1959, 12p. (AFOSR-TN-59-1287) (AF 49(638)619) AD 231597; PB 145506 Unclassified

The main theorem gives necessary and sufficient conditions in order that each positive continuous function on $[0, 1]$ be approximable by polynomials with positive coefficients in 2 given functions. Fairly general necessary conditions are found for such approximation by positive linear combinations of given functions or by powers of given functions.

2060

Syracuse U. [Dept. of Physics] N. Y.

ELECTRON SPIN-LATTICE RELAXATION IN PHOSPHORUS DOPED SILICON, by A. Honig and E. Stupp. June 30, 1959 [45]p. incl. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TN-59-715) (AF 18-(603)50) AD 218352; PB 143023 Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 261, Apr. 30, 1959. (Title varies)

Also published in Phys. Rev., v. 117: 69-83, Jan. 1, 1960.

Electron spin-lattice relaxation in phosphorus doped silicon was investigated over a magnetic field range of 0 - 11,000 oersteds, a temperature range of 1.25°K to 4.2°K, and a concentration range of 10^{14} P/cc to 3×10^{16} P/cc. Three distinct τ_s ($\Delta m_s = \pm 1$, $\Delta m_l = 0$) relaxation mechanisms were identified, and their functional dependence on magnetic field, temperature and concentration were determined. The theoretical origins of the mechanisms are discussed. A theory is proposed to explain the concentration dependent τ_s mechanism, according to which rapidly relaxing close pairs of phosphorus atoms, which are few in number, relax the spins of the large number of isolated phosphorus atoms via a spin diffusion process. Experiments supporting this hypothesis are presented.

2061

Syracuse U. Dept. of Physics, N. Y.

STUDY OF THE MIGRATION AND DESORPTION OF A DIMORPHIC ADSORBATE USING THE FIELD EMISSION MICROSCOPE: TITANIUM ON TUNGSTEN, by R. C. Abbott and A. M. Russell. June 1959, 49p. incl. refs. (AFOSR-TR-59-89) (AF 49(638)93) AD 220827; PB 143678 Unclassified

The migration and desorption of titanium on tungsten was measured by the field emission technique and the activation energies for these processes were determined. In addition, estimates were made for the average number of titanium-titanium and titanium-tungsten bonds broken during migration and desorption. Two distinct migrations were observed: an early stage of migration that took relatively little time to go to completion and a later stage migration with a much longer (~ factor of 10) completion time. The early stage migration has 2 values of activation energy: 2.4 ± 0.1 ev above $T = 847^\circ\text{C}$ and 2.6 ± 0.2 ev below this temperature. The characteristic time necessary for the early stage migration to achieve a given degree of completion changes discontinuously at $T = 847^\circ\text{C}$ by a factor of 2.3.

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The later stage migration activation energy is 2.0 ± 0.1 ev. The desorption activation energy is 6.4 ± 0.2 ev. A possible explanation for this abrupt change in characteristic time, involving the dimorphism of the adsorbate, is discussed. It is postulated that this abrupt change is caused by the excellent fit of the adsorbed titanium layer to the b.c.c. structure of the tungsten substrate when $T > 847^\circ\text{C}$. Pure titanium transforms from a low temperature h.c.p. to a b.c.c. structure at 883°C . Comparison of calculated bond strengths with the experimentally determined activation energies indicates that an average of 2 Ti-W bonds are broken during early stage migration, while 1 Ti-W and 1 Ti-Ti bond are broken during later stage migration. An average of 4 Ti-W and 2 Ti-Ti bonds are broken during desorption. (Contractor's abstract)

2062

Syracuse U. Dept. of Physics, N. Y.

DIPOLE MOMENT FUNCTION OF DIATOMIC MOLECULES, by J. Trischka and H. Salwen. [1959] [8]p. incl. tables. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)93] and Office of Naval Research) Unclassified

Published in Jour. Chem. Phys., v. 31: 218-225, July 1959.

The connection between the dipole moment function (dipole moment as a function of internuclear distance), $M(u)$, and its matrix elements were studied for the 1-dimensional model of a diatomic molecule. It is shown that $M(u)$ is completely determined by a single row or column of the matrix $\langle v | M(u) | v' \rangle$, but that the diagonal matrix elements do not completely determine $M(u)$. Attention is given to the problem of approximating $M(u)$ when a finite number of matrix elements are known. The usual method (called the "polynomial approximation") is compared with a new approximation scheme which is called the "wave function approximation." These methods are equivalent for a harmonic oscillator, but not in general. Estimates of the errors of the 2 methods are obtained in the case where the anharmonicity of the potential is small. The "wave-function expansion" of $M(u)$ which is developed and used to carry out the calculations is a new way of relating matrix elements to $M(u)$ which makes it much easier to calculate the dipole moment function from its matrix elements. This method has been used to obtain explicit formulas relating the dipole moment function to its matrix elements for the harmonic oscillator and for the Morse oscillator. (Contractor's abstract.)

2063

Syracuse U. Dept. of Physics, N. Y.

DIPOLE MOMENT FUNCTION OF $\text{CO}(\Sigma^+)$, by H. Salwen and J. Trischka. [1959] [3]p. incl. tables.

(Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)93] and Office of Naval Research) Unclassified

Published in Jour. Chem. Phys., v. 31: 541-543, Aug. 1959.

The possible dipole moment functions of $\text{CO}(\Sigma^+)$ are calculated by means of the wave function approximation with wave functions for a Morse potential. The dipole moment functions are expressed as polynomials whose coefficients through the quartic terms are given in a table. The accuracy of the dipole moment functions is discussed for the case in which only the 1st 2 vibrational matrix elements are known. This discussion is based on calculations made by both the wave function approximation and an older method, the polynomial approximation. A Morse potential and a polynomial potential are compared to determine their relative suitability for the calculation of the dipole moment function of $\text{CO}(\Sigma^+)$. (Contractor's abstract)

2064

Syracuse U. Dept. of Physics, N. Y.

NEW POTENTIAL FOR IRREVERSIBLE PROCESSES, by P. G. Bergmann and E. Morris. [1959] 11p. (AFOSR-TN-59-510) (AF 49(638)461) AD 264065 Unclassified

Also published in Ann. Phys., v. 8: 266-270, Oct. 1959.

If a system is driven by several reservoirs, then 2 different Gibbsian distributions, both of which obey the Liouville equation with additional stochastic terms will approach each other in the course of time. A whole class of positive-definite functionals of these 2 distributions, which decrease monotonically in the course of time is given. A result is the construction of a functional of a single distribution, also positive-definite, which tends to zero monotonically in the course of time and which will equal zero only if the distribution is stationary. (Contractor's abstract)

2065

Syracuse U. [Dept. of Physics] N. Y.

VARIATIONAL PRINCIPLE FOR STATIONARY IRREVERSIBLE PROCESSES (Abstract), by P. G. Bergmann. [1959] [1]p. [AF 49(638)461] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 244, Apr. 30, 1959.

If a system which internally obeys the laws of classical

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mechanics is exposed to continuing contact with several inexhaustible reservoirs, its Gibbsian distribution in phase space will tend asymptotically to a stationary distribution, which is independent of the initial distribution and which will not be canonical if the driving reservoirs are at different temperatures. It will be shown that the quantity $K = \int \mu^{-1} \mu^2 dX$, which is positive definite, decreases monotonically in the course of time and approaches zero asymptotically. Accordingly, it is suggested that K is a natural expression for the determination of how close a given distribution is to the stationary distribution, and that it may be suitable for the construction of approximation procedures leading to the stationary distribution.

2066

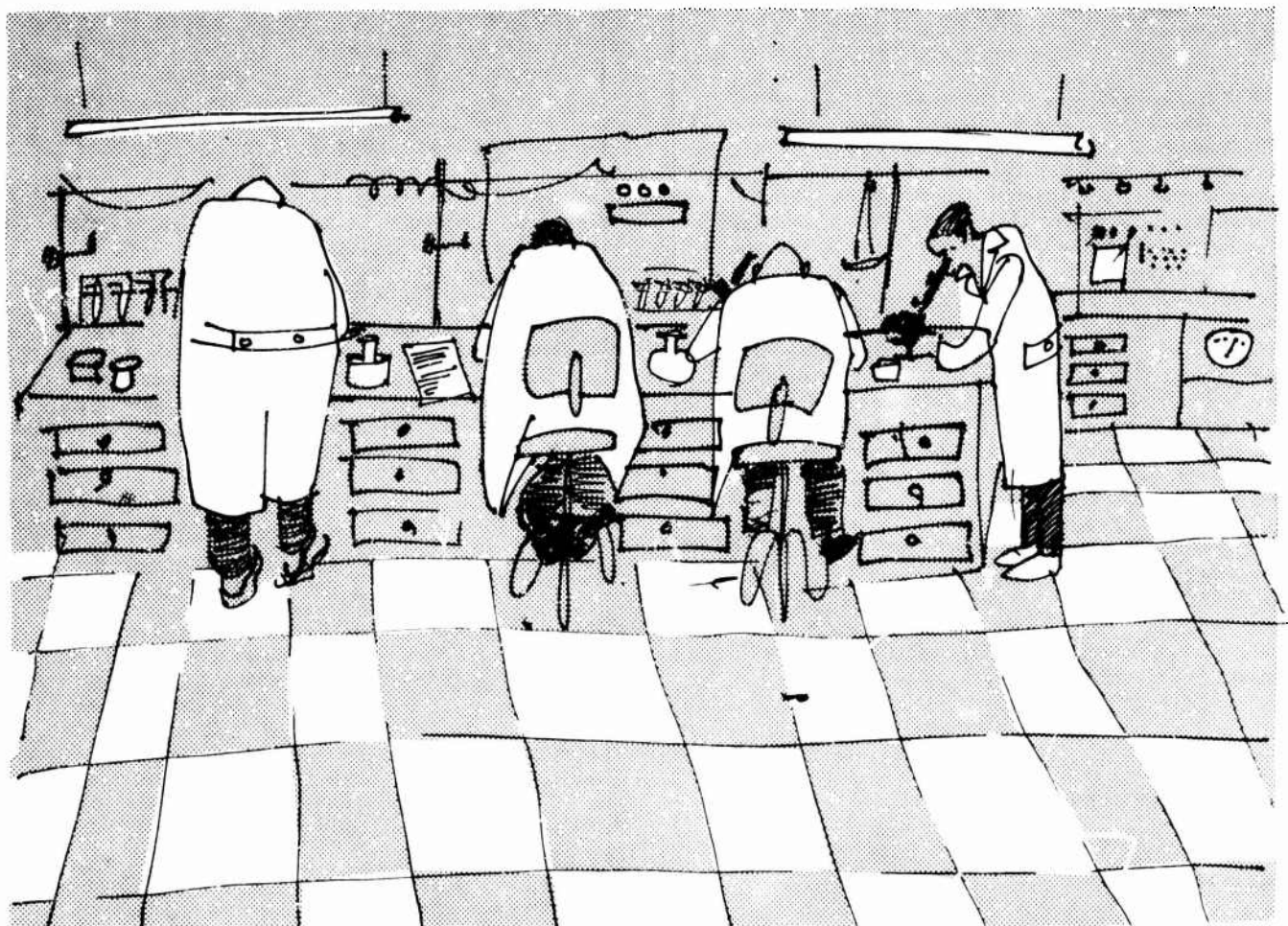
Syracuse U. [Dept. of Physics] N. Y.

COMMUTATION RELATIONS BETWEEN OBSERVABLES IN GENERAL RELATIVITY (Abstract), by A. Kumar and P. G. Bergmann. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)461] and National Science Foundation)
Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 294, Apr. 30, 1959.

A method for constructing a complete set of observables in general relativity was described previously (Phys. Rev., v. 111: 1182, 1958). Commutators (Poisson brackets) between 2 observables may be interpreted as the (infinitesimal) change in 1 observable induced by the infinitesimal invariant canonical transformation generated by the other. As this interpretation will serve as an unambiguous definition in either a Hamiltonian or a Lagrangian formalism, a Lagrangian approach is chosen. As the generating observable an integral is used over a 3-dimensional hyper-surface whose integrand is a linear combination of the components of the curvature tensor; the coefficients are functions arbitrary throughout the domain of integration. This calculation yields commutators between components of the curvature tensor and components of the metric tensor and its derivatives in an "intrinsic" coordinate system. It is believed that the method can be extended to different generators as well, so that it will lead to commutators between any pairs of observables.



AIR FORCE SCIENTIFIC RESEARCH

2067

Technical Research Group, New York.

RESEARCH ON NUCLEAR MAGNETIC RESONANCE TECHNIQUES, by M. Newstein. Final rept. Apr. 1959, 96p. incl. diagrs. table, refs. (AFOSR-TR-59-26) (AF 18(600)1313) AD 212008; PB 140624

Unclassified

Shimming an inhomogeneous magnetic field in nuclear resonance by pulses is reviewed. Results indicate that there is a combination of shimming pulses that can be applied to a liquid sample which can make the linewidth of the sample independent of the degree of homogeneity of the external static magnetic field. A mathematical analysis is presented of the behavior of the transient solution, and integral of the transient solution, under various conditions of excitation. A technique is described and analyzed by means of which a steady state signal may be obtained using 2 resonating nuclei instead of one. A new type of Maser, the traveling-wave gas cell Maser, is reviewed and analyzed. An explanation and analysis is included regarding certain pulse experiments which lead to the production of undesired signals. Experimental and theoretical work on optical detection of magnetic resonance is reviewed. The use of optical pumping and optical detection has permitted the observance of both Zeeman and field-independent magnetic resonances in alkali vapors.

2068

Technion - Israel Inst. of Tech., Haifa.

RESEARCH ON CROSS-STRESSES IN THE FLOW OF LIQUIDS, by M. Reiner. Technical rept. Oct. 1, 1957-Sept. 30, 1958 [27]p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-37) (AF 61(052)10) AD 209209; PB 145166

Unclassified

An instrument is described which works as a centripetal vacuum pump. It consists of two circular metal plates, one stationary, the other rotating opposite it. The stator has an opening in the centre. The rotor can be freely displaced along the axis of rotation. By centripetal pumping action it is kept floating on an air cushion of thickness D. The relation between D and the speed of rotation was determined for different weights of the rotor to be supported. The results are interpreted on the basis of Maxwell's theory of the elasticoviscosity of air. Also, an instrument is described which works as a centripetal pressure pump with incompressible liquids. (Contractor's abstract)

2069

Technion - Israel Inst. of Tech., Haifa.

BUCKLING OF CONICAL SHELLS UNDER EXTERNAL PRESSURE AND THERMAL STRESSES, by J. Singer

and N. J. Hoff. Final technical rept. Dec. 1959 [82]p. incl. diagrs. refs. (AFOSR-TR-59-203) (AF 61(052)-123) AD 236855; PB 147497

Unclassified

Simplified differential equations governing the deformations of deep thin circular conical shells subjected to arbitrary loads and arbitrary temperature distributions are derived by the principle of the minimum total potential energy. The equations reduce to Donnell's [NACA Rept. No. 479, 1933] equations (extended to include an arbitrary temperature distribution) when the cone angle approaches zero. An asymptotic solution of these simplified equations is then obtained for a truncated conical shell subjected to an axisymmetrical temperature distribution. The equations are then extended to include problems of elastic stability. The stability equations are solved for loading under lateral and under hydrostatic pressure in the presence of slightly relaxed boundary conditions for the u and v displacements; for the w (radial) displacements the usual conditions of simple support are enforced rigorously. The same method of solution, with the slightly relaxed boundary conditions for the u and v displacements, is then applied to the thermal buckling problem of truncated conical shells subjected to axisymmetrical temperature distributions. A typical example is analyzed in detail. (Contractor's abstract)

2070

Technion - Israel Inst. of Tech., Haifa.

BOUNDS FOR SUMS OF RECIPROCAL OF EIGENVALUES, by B. Schwarz. July 1959 [18]p. incl. refs. (Technical scientific note no. 1) (AFOSR-TN-59-620) (AF 61(052)194) AD 217684; PB 145298

Unclassified

Also published in Bull. Research Council, Israel, v. 8F: 91-102, Dec. 1959.

The differential system $y''(x) + \lambda p(x)y(x) = 0$ is considered where $y(\pm a) = 0$, $0 < a < \infty$, $p(x) > 0$, and $p(x) \in C$. Denoting the eigenvalues by $\lambda_n(p)$ ($n = 1, 2, \dots$), bounds are found for $\sum_{n=1}^{\infty} \frac{1}{\lambda_n(p)}$. These bounds are given by

the analogous sums for the systems in which $p(x)$ is replaced by its symmetrical rearrangements in $[-a, a]$. An analogous system for $q(x)$ is considered. If

$\int_{-a}^a p(x)dx \leq \int_{-a}^a q(x)dx$, and if there exists a value b , $0 < b < a$, such that $q(x) \geq p(x)$ in $[-b, b]$ and $q(x) \leq p(x)$

in $[-a, -b]$, then $\sum_{n=1}^{\infty} \frac{1}{\lambda_n(p)} \leq \sum_{n=1}^{\infty} \frac{1}{\lambda_n(q)}$. Similar rela-

tions are proved for other differential systems. Finite sums of the reciprocals of the eigenvalues $\lambda_n(p)$ are considered only under certain conditions on $p(x)$. For each positive integer N a lower bound for the sum of the reciprocals of the first N eigenvalues is given. (Contractor's abstract)

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2071

Technion - Israel Inst. of Tech., Haifa.

THE PHYSICS OF AIR-VISCOSITY AS RELATED TO GAS-BEARING DESIGN, by M. Feiner. [1959] [12]p. incl. illus. diags. (AFOSR-1000) (AF 61(052)223) AD 277352 Unclassified

Also published in Proc. First Internat'l. Symposium on Gas Lubricated Bearings, Washington, D. C. (Oct. 26-28, 1959), Washington, Office of Naval Research, 1959, p. 307-318.

This study is concerned with that action of gases which permits the development of positive pressure when (a) the bearing surfaces are parallel, and, at the same time, (b) there is no supply of air under pressure from an external pump. The action described is the result of a hitherto unknown effect in the laminar flow of fluids which may be named cross-effect, because it is a manifestation of normal stresses in cross-wise directions, i.e., in the direction of flow, in the direction of the velocity gradient, and in the direction normal to both. An instrument showing the effect is described and an outline of the theoretical background is given. (Contractor's abstract)

2072

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

ON 2-DIMENSIONAL SHOCK-WAVES FOR NEAR-DETACHMENT FLOW, by A. Kogan. [1958] [6]p. incl. diagr. table. (AF 61(052)06) Unclassified

Published in Bull. Research Council Israel., v. 7F: 127-128, Nov. 1958.

Crocco's stream function equation is transformed by choosing the stream function as an independent variable. It is shown that in the case of near shock-detachment flow, the transformed equation can be well approximated by an ordinary differential equation which is readily integrated. Approximate relations between temperature and pressure distributions along the airfoil and the shock-wave form are derived. (Contractor's abstract)

2073

Technion - Israel Inst. of Tech. Dept. of Aeronautical Engineering, Haifa.

ON ROTATIONAL FLOW PAST THICK AIRFOILS, by A. Kogan. Final rept. Feb. 1959 [37]p. incl. diags. table. (AFOSR-TR-59-64) (AF 61(052)06) AD 217033 Unclassified

Also published in Jour. Aero/Space Sci., v. 27: 504-508, July 1960. (Title varies)

The inviscid rotational supersonic flow behind the shock wave attached to the sharp leading edge of an airfoil is studied by a transformation of coordinates which introduces the Crocco stream function ψ as independent variable. Using expansions in power series of ψ an iterative process is developed for the determination of pressure distribution along the airfoil surface. For the special case of near-shock-detachment flow a simple approximation is derived for the flow in the whole region between the airfoil and the shock wave. (Contractor's abstract)

2074

Technion - Israel Inst. of Tech. Dept. of Mathematics, Haifa.

ON FUNCTIONS ALMOST ALL OF WHOSE MOMENTS VANISH, by J. Steinberg. [1959] [4]p. (AF 61(052)192) Unclassified

Published in Bull. Research Council Israel, v. 8F: 129-132, Dec. 1959.

The zeroes and asymptotic behavior of certain functions is discussed. Except for a finite number of them, all moments along the real axis vanish.

2075

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

GRAVITATIONAL MOTION AND RADIATION. I, by A. Peres. [1959] [11]p. incl. refs. [AF 61(052)428] Unclassified

Published in Nuovo Cimento, Series X, v. 11: 617-627, Mar. 1, 1959.

A method is established to solve Einstein's equations by successive approximations, uniqueness and compatibility at each step being secured by imposing de Donder's condition on the field. This turns out to restrict the freedom of choice of the sources in a way that determines their laws of motion, directly from the field quantities, without any use of integration around singularities. If the approximation parameter is the reciprocal velocity of light, the 1st non trivial approximation results in the constancy of the rest mass, and in Newton's law of attraction. The next step shows that there is no 1st-order correction to these laws. The 3rd approximation then gives a small correction to the rest mass, which is found to be increased by the presence of other bodies. There is also a 2nd-order correction to the acceleration (not explicitly evaluated here) which causes the perihelion advance in the 2-body problem. The 4th approximation involves a contribution from the radiation field. It is found that in order to fulfill de Donder's condition, we must introduce into the field a term which is linear in the sources, although it does not appear in the so-called "linear approximation". This result may cast some doubts on the validity of the

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latter. In a further paper, we shall solve still higher approximations by means of an improved technique, and find that the 5th-order correction to the acceleration involves a non-conservative term. This last result may be taken as evidence for the reality of gravitational radiation. (Contractor's abstract)

2076

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

GRAVITATIONAL MOTION AND RADIATION. II., by A. Peres. [1959] [12]p. incl. refs. [AF 61(052)428] Unclassified

Published in Nuovo Cimento, Series X, v. 11: 644-655, Mar. 1, 1959.

General relativistic laws of motion for slow particles are deduced from successive approximate solutions of Einstein's equations, subject to de Donder's conditions. The 1st 3 approximations give results identical with those of the previous paper (item no. 2075) (Newtonian and post-Newtonian equations of motion). Higher approximations involve contributions from the radiation field. It is found that they can be treated independently of other relativistic effects, and cause 5th-order corrections to the rest-masses and accelerations of the particles. In particular, it is shown that as a consequence of gravitational radiation, a system of particles gains energy, thus implying that gravitational waves carry away a negative amount of energy. This is made plausible by showing that the energy density of the gravitational field is also a negative quantity. An electromagnetic analogy of these results is proposed.

2077

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

GRAVITATIONAL MOTION AND RADIATION. III, by A. Peres. [1959] [3]p. [AF 61(052)428] Unclassified

Published in Nuovo Cimento, Series X, v. 13: 439-441, July 16, 1959.

It is shown that the secular change of the total gravitational mass of a system of 2 bodies, uniformly rotating around each other, is exactly equal to minus the radiated energy (independently computed in the previous part of this paper. (Contractor's abstract)

2078

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

ON CAUCHY'S PROBLEM IN GENERAL RELATIVITY, by A. Peres and N. Rosen. [1959] [9]p. incl. refs. [AF 61(052)428] Unclassified

Published in Nuovo Cimento, Series X, v. 13: 430-438, July 16, 1959.

It is shown that a suitable set of Cauchy's conditions for Einstein's equations in vacuo consists in specifying the values of g_{kl} and $g_{kl,0}$ on a hypersurface $x^0 = 0$. The corresponding g_{0k} are to be found by solving 2 spatial 2nd order differential equations, and g_{00} is then given by an algebraic relation. The 1st and higher time derivatives of $g_{0\mu}$ remain completely undetermined by the field equations, thus leaving room for arbitrary coordinate transformations. It is further shown that even if the g_{kl} are chosen close to their Galilean values, and if the $g_{kl,0}$ are small, the remaining $g_{\mu\nu}$ will in general not be close to their Galilean values. However, a detailed investigation of the physical components of the curvature tensor shows that the field can nevertheless be weak, thus implying that the large discrepancies between the $g_{0\mu}$ and their Galilean values are only a coordinate effect. The field is really strong only close to domains where the determinant of the $g_{\mu\nu}$ vanishes. By a suitable coordinate transformation, those domains can be made to shrink to points, and the resulting singularities may be interpreted as representing matter. This supports Einstein's view that matter should not be considered as something foreign to the metric field itself. (Contractor's abstract)

2079

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

ON GRAVITATIONAL RADIATION, by A. Peres. [1959] [1]p. [AF 61(052)428] Unclassified

Published in Nuovo Cimento, Series X, v. 13: 670, July 16, 1959.

A criterion is given which partly removes the ambiguity which arises in connection with the solutions (in previous studies) of Einstein's equation representing incoming gravitational waves, the presence of which account for the negative radiated energy previously obtained.

2080

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

NONLINEAR EFFECTS OF GRAVITATIONAL RADIATION, by A. Peres and N. Rosen. [1959] [2]p. [AF 61(052)428] Unclassified

Published in Phys. Rev., v. 115: 1085-1086, Aug. 15, 1959.

It is shown that the cumulative effects of the nonlinear terms in Einstein's equations rule out the possibility

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of stable small oscillations of a gravitational field about an equilibrium state, if the latter is supposed to be Minkowskian at infinity. The perturbation, if unlimited in time, rather tends to take infinite values at large distances from its source. This can be interpreted as an instability of gravitational radiation fields, and raises doubts concerning the validity of the linearized theory at large distances from the source. (Contractor's abstract)

2081

Technion - Israel Inst. of Tech. Dept. of Physics, Haifa.

SOME GRAVITATIONAL WAVES, by A. Perez. [1959] [2]p. [AF 61(052)428] Unclassified

Published in Phys. Rev. Lett., v. 3: 571-572, Dec. 1959.

By considering the metric $ds^2 = -dx^2 - dy^2 - dz^2 + dt^2 - 2f(x,y,z+t)(dz+dt)^2$, a new class of solutions of the Einstein gravitational equations is derived. Some particular cases of the function f are briefly examined.

2082

Technische Hochschule. Inst. für Mechanik, Aachen (Germany).

MEASUREMENTS OF THE DIFFUSION OF ELECTRONS OUT OF STRONG SHOCK WAVES, by H. Groenig. Final rept. June 1959 [42]p. incl. illus. diagrs. refs. (AFOSR-TR-59-160) (AF 61(514)1046) AD 232219; PB 145680 Unclassified

The diffusion processes which occur with the transition of strong shock waves in gases were investigated by means of a gas discharge probe developed for these purposes. It was found theoretically and experimentally that ahead of strong, ionizing shocks electrons can be measured which escape the shock region by diffusion. The experimentally obtained diffusion profiles are in good agreement with the solution of the diffusion equation. It is possible to determine the diffusion coefficient for electrons in argon from the measurements. The diffusion coefficient exhibits the correct pressure dependence. The experiments were performed in argon of different degrees of impurities. No difference with the various degrees of impurities can be observed. The Mach numbers were restricted to the range of 5 to 10, where the experiments are most interesting due to the relatively small degree of ionization. (Contractor's abstract)

2083

Technische Hochschule. Inst. für Aerodynamik, Braunschweig (Germany).

THEORETICAL AND EXPERIMENTAL CASCADE

FLOW INVESTIGATIONS AT HIGH SUBSONIC MACH NUMBERS (PRESSURE DISTRIBUTIONS AND WAKE MEASUREMENTS), by U. Hopkes. June 26, 1959, 55p. incl. diagrs. tables, refs. (Rept. no. 59/21) (AFOSR-TR-59-45) (AF 61(052)105) AD 214810; PB 145501

Unclassified

Extensive experimental investigations on 2-dimensional cascades at high subsonic Mach numbers were carried out in the variable density high speed cascade wind tunnel. Varying the cascade geometry and the Mach number the following quantities were measured up to the choking Mach number for 2 different blade profiles (NACA 0010 and NACA 8410): (1) pressure distribution on the blade, (2) loss coefficient and (3) deflection of flow and static pressure difference across the cascade. The loss coefficient and the deflection are nearly constant up to the critical Mach number, but the static pressure difference varies with the Mach number. The experimental pressure distributions were compared with different theoretical methods for calculating pressure distributions in compressible flow.

2084

Technische Hochschule, Hannover (Germany).

DYNAMICS OF STRUCTURES BY TRANSFER MATRICES, by E. Pestel. June 1959 [184]p. incl. diagrs. tables, refs. (Technical rept. no. 1) (AFOSR-TR-59-95) (AF 61(052)33) AD 226677; PB 144294

Unclassified

This report describes in detail the dynamics of transfer matrices from a structural viewpoint. The 1st chapter reviews briefly the method of transfer matrices with an example of the free plane bending vibration of a straight beam on 2 supports. Each chapter after that deals with a particular phase of the subject. The 2nd discusses calculation of rotating disks under transfer matrices by examining stresses and strains, free bending vibration, and forced vibration. The 3rd deals with the catalogue of transfer matrices of which there are 3: straight beams, curved and twisted beams, and beams with special intermediate conditions. The 4th discusses the coupling of beams. Delta-matrices and other modifications of the use of transfer matrices are examined in the next chapter. The following chapter, concerned also with the static and dynamic analysis of various elastomechanical problems, discusses the modified transfer matrix method. The next chapter, analysis of aircraft components structurally, presenting for perhaps the 1st time, an investigation of stresses and strains in a thin-walled aircraft. The last chapter is an application of transfer matrices to plates.

2085

Technische Hochschule. Inst. für Statik, Hannover (Germany).

THIN-WALLED COMPRESSION MEMBERS, by A.

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Pfluger. Dec. 1958, 37p. incl. diagrs. tables, refs.
(Rept. no. 1) (AFOSR-TN-59-291) (AF 61(514)1140)
AD 212923: PB 140693

All the main problems arising in the calculation of centrally loaded thin-walled columns are considered. In particular formulas and graphs are worked out for buckling by torsion and flexure, for local buckling of the walls and for behavior beyond the buckling load, either compiled from existing sources or from new investigations. To clarify certain questions it was necessary to carry out tests. This report treats, however, only problems which could be solved theoretically and embraces mainly the relations within the range of elasticity and up to the buckling strength.

2086

Technische Hochschule. Inst. für Statik, Hannover
(Germany).

THIN WALLED COMPRESSION MEMBERS, by A. Pflüger. Final rept. July 1959, 14p. incl. diagrs. refs. (Rept. no. 2) (AFOSR-TR-59-138) (AF 61(514)1140) AD 227149; PB 144313

Test results indicated that the ideal local buckling stress on thin-walled compression members can be reduced in the same way as was done for column buckling. The magnitude of the deformations occurring as a result of the buckling process was investigated. As a consequence of inaccuracies of shape and of the application of the load, deformations probably will occur before the buckling limit is reached. The statistical evaluation of the measurements showed that these deformations do not exceed the permissible limits within the scope of reasonable demands regarding the outer appearance of a construction. When the critical value is exceeded, the deformations increase rapidly. Consequently, the necessary safety factor must be related to the buckling limit. The yield stress values to be introduced into the buckling formula when making allowances for the difference between compressive and tensile yield stress as well as for the effect exercised by the manufacturing process are discussed. Allowances for the cladding effect may be achieved by multiplying the buckling stress with a corrective factor involving the cladding thickness, sheet thickness and the yield stress of the cladding material.

2087

Technische Hochschule. Inst. für Angewandte
Mathematik, Karlsruhe (Germany).

RING AIRFOIL THEORY PROBLEMS OF INTER-
FERENCE AND BOUNDARY LAYER, by J. Weissinger.
Jan. 1959 [105]p. incl. diagrs. tables, refs. (AFOSR-
TN-59-226) (AF 61(514)1207) AD 211809; PB 140694
Unclassified

The investigations of a recent report (TEK.02:001,

Vol. 11) were continued. As a new subject the interference of the ring with a strut (of small chord length) is studied. The theory of ring body interference is extended to (slender) bodies of finite length whose diameter is small compared with the ring diameter. In this report also the shape parameter $\lambda = L/D$ is assumed to be small. The lift of the body and of the wing as well as the pitching moment of the body were determined; explicit formulas and numerical results are given for ellipsoids of revolution. In boundary layer theory the methods were improved by introducing the Mangler transformation and some minor refinements. (Contractor's abstract)

2088

Technische Hochschule. [Mathematical Inst.] Munich
(Germany).

**SUPERSONIC FLOW PAST OSCILLATING BODIES OF
REVOLUTION WITH A FREQUENCY NOT NECESSARI-
LY SMALL, by J. Muench. June 24, 1959, 13p. incl.
diags. (Technical note no. 8) (AFOSR-TN-59-452)
(AF 61(514)1080) AD 215027; PB 143965**

A representation is given of the potential of linearized flow past bodies of revolution executing elliptic oscillations of arbitrary frequency. The potential is given in terms of Bessel and Legendre functions. (Contractor's abstract)

2089

Technische Hochschule. [Mathematical Inst.] Munich
(Germany).

THE NUMERICAL SOLUTION OF BOUNDARY-VALUE PROBLEMS FOR CERTAIN HYPERBOLIC LINEAR EQUATIONS, by H. J. Stetter. Apr. 24, 1959 [33]p. incl. diagrs. refs. (Technical note no. 7) (AFOSR-TN-59-673) (AF 61(514)1080) AD 218385. PB 143164

Unclassified

A detailed investigation is given of procedures yielding a numerical solution of certain boundary-value problems of a linear partial differential equation related to the wave equation. After the statement of the problem and the presentation of some analytic results, the characteristic system of the equation is transcribed into a system of difference equations in a characteristic grid, using an ADAMS-interpolation difference scheme. It is shown how these difference equations may be conveniently solved in each point of the grid. A method is presented to take care of discontinuities in the boundary data. The numerical procedures necessary to get the computations on the difference equations started are also described. The stability and convergence of these numerical methods is discussed. Stability is investigated experimentally through the propagation of unit-errors; convergence is theoretically and experimentally found to be of $O(h^3)$, h being the mesh-size. The

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results of computations on a practical example originating from aerodynamics are presented. (Contractor's abstract)

2090

Technische Hochschule. [Mathematical Inst.] Munich (Germany).

RIEMANN'S PROBLEM FOR A LAVAL-NOZZLE. I. HYDRAULIC APPROXIMATION, by R. Schätz. Aug. 12, 1959 [23]p. incl. diagrs. (Technical note no. 9) (AFOSR-TN-59-709) (AF 61(514)1080) AD 230223; PB 145296
Unclassified

Hydraulic approximation is discussed of Riemann's problem, i.e., the determination of flow arising from discontinuous initial pressure distribution, for Laval nozzles, and a detailed analysis is presented of numerical features of difference methods employed. (Contractor's abstract)

2091

Technische Hochschule. Mathematical Inst., Munich (Germany).

LINEAR SUPERSONIC FLOW PAST COMBINATIONS OF A CYLINDRICAL BODY AND TRIANGULAR WINGS, by F. Peischl and H. J. Stetter. Nov. 24, 1959, 28p. incl. diagrs. refs. (Technical note no. 11) (AFOSR-TN-59-1160) (AF 61(514)1080) AD 233274; PB 146737
Unclassified

The normalized pressure-distribution has been computed for wing-body combinations consisting of an infinite (rotational) cylindrical body and plane delta-wings with supersonic leading edges. Linear supersonic theory was used without further approximations. After an introduction on quasi-cylindrical wing-body interference theory and the statement of the problem the non-trivial 2nd step of the procedure is solved analytically. This solution is Fourier-analyzed numerically to yield the boundary data for the 3rd step, the computations of which have been described previously. (See item no. 2089). The pressure distribution is shown in several graphical representations and a discussion of the results is given. All computations were made on the PERM electronic computer. (Contractor's abstract)

2092

Technische Hochschule, Stuttgart (Germany).

INVESTIGATION OF THREE-DIMENSIONAL VORTEX INSTABILITY, by F. X. Wortmann. Final technical rept. Feb. 25, 1959 [17]p. incl. illus. diagrs. table. (AFOSR-TR-59-59) (AF 61(514)897) AD 216624; PB 143014
Unclassified

A description is presented of the development and construction of a laminar water tunnel designed for the investigation of a 3-dimensional vortex instability of the laminar boundary layer on the concave wall. Both the assignment and the tellurium method have brought up problems for the solution of which entirely new approaches had to be found. Apart from the solution of a large variety of individual problems a rigid, porous, corrosion-resistant wall surface was developed for boundary layer suction. (Contractor's abstract)

2093

Technische Hochschule, Vienna (Austria).

CONDUCT THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF THE MIXING OF COOLING AIR WITH COMBUSTION PRODUCTS IN A COMBUSTION CHAMBER, by H. Melan. Final technical rept. Oct. 31, 1959 [32]p. incl. illus. diagrs. tables. (AFOSR-TR-59-197) (AF 61(052)93) AD 241992; PB 150332
Unclassified

A new combustion chamber for gas turbines was tested. The chamber design included a swirl (vortex) chamber at the inlet and exhaust of the combustion chamber. The tests were made with a model derived from a standard Lucas chamber. Measurements were made of the velocities, pressures, temperatures, mass flow, and combustion efficiencies during the investigation of the flow of hot gases and cooling air in the chamber. The results indicated that the flame tube could be successfully eliminated from the combustion chamber and that wall temperatures could be diminished by the design. It also appeared possible to get a similar distribution of the outlet temperatures over the cross section of the outlet.

2094

Temple U. [Dept. of Physics] Philadelphia, Pa.

NATURE OF ABSORPTION EDGE ELECTRON TRANSITIONS IN β -BRASS ALLOYS (Abstract), by L. Muldawer. [1959] [1]p. [AF 49(638)73] Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 46, Jan. 28, 1959.

Spectral reflectivity measurements at room temperature of β -brass alloys show a shift of the edge to lower energy with increasing zinc content. A similar effect is seen in β -AgCd alloys. This indicates the operation of an electron transition from the top of the Fermi sea to an upper band and not from the underlying d band to the surface of the Fermi sea. The latter is the responsible mechanism in the α -brasses. The observed reflectivity edge shift in β -brass is -0.031 eV/% Zn. A simple calculation assuming only electron-atom ratio

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and lattice parameter changes gives a Fermi level shift of + 0.029 eV/% Zn; this is in good agreement with the above scheme providing the electron band structure undergoes negligible changes.

2095

Temple U. Research Inst., Philadelphia, Pa.

THE FASTEST BURNING FLAME—THE PRE-MIXED HYDROGEN-FLUORINE FLAME, by A. V. Grosse and A. D. Kirshenbaum. Feb. 2, 1959, 72p. incl. illus. diagrs. tables, refs. (Technical note no. 8) (AFOSR-TN-59-621) (AF 18(600)1475) AD 228782; PB 144981 Unclassified

Techniques for premixing pure hydrogen and fluorine gas were developed. Burning velocities, both at 77 and 90°K of various hydrogen-fluorine mixtures, with and without helium dilution, were determined. The hydrogen-fluorine flame is the fastest flame known and burning velocities up to 2100 cm/sec at 77°K were measured. Under the same conditions the hydrogen-oxygen flame has a velocity of approximately 200 cm/sec or 10 times smaller. The hydrogen-fluorine flame is also characterized by an unusually high flame pressure; a maximum of 60 mm Hg has been determined. (Contractor's abstract)

2096

Temple U. Research Inst., Philadelphia, Pa.

AN EXPERIMENTAL DETERMINATION OF THE DENSITIES OF MOLTEN METAL FLUORIDES IN THE RANGE OF 1600° TO 2500°K, by A. D. Kirshenbaum and J. A. Cahill. Apr. 30, 1959, 45p. incl. illus. diagrs. tables, refs. (Technical note no. 9) (AFOSR-TN-59-844) (AF 18(600)1475) AD 231147; PB 145363 Unclassified

Using a graphite crucible and a tungsten sinker, the liquid densities of the alkaline earths and 2 rare earth fluorides were determined by the loss in weight of an immersed sinker method over a temperature range of 1600° to 2500°K. The density equations for these molten fluorides are given in table form.

2097

Temple U. Research Inst., Philadelphia, Pa.

STUDY OF ULTRA HIGH TEMPERATURES, by A. V. Grosse and C. S. Stokes. Final rept. May 1, 1955-Apr. 30, 1959, 26p. incl. diagr. table, refs. (AFOSR-TR-59-168) (AF 18(600)1475) AD 231063; PB 161460 Unclassified

This final rept. covers such topics as: The production of high temperature flames; Systems of carbon, nitrogen and oxygen; The cyanogen-oxygen flame as a high

temperature tool; Systems using fluorine; The fastest burning flame - the premixed hydrogen-fluorine flame; Systems using ozone; Imaging of the oxygen-aluminum flame and its use as an artificial sun furnace; Two phase reactions at high temperatures; The reaction of beryllium with aluminum oxide; Combustion of beryllium in oxygen; The temperature of the zirconium-oxygen flame; An experimental determination of the densities of molten metal fluorides in the range of 1600° to 2500°K; Preparation of carbon-phosphorus compounds.

2098

Texas A. and M. Coll. [Dept. of Physics] College Station.

SOME FEATURES OF THE VIBRONIC ABSORPTION SPECTRUM OF CHLORINE DIOXIDE (Abstract), by J. B. Coon and C. M. Loyd. [1955] [1]p. [AF 18(600)-439] Unclassified

Presented at the Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 1955.

A critical list of 143 bands of the 3000-5000A absorption system of Cl^{35}O_2 has been compiled. This list is based on published data supplemented by the present authors. A vibrational analysis yields accurate values for 3 fundamental frequencies and all 6 anharmonicity constants of the excited electronic state. In addition, accurate values are obtained for the frequencies of the 2 symmetrical modes of the ground state and the 3 anharmonicity constants associated with these frequencies.

Most of the assigned bands are arranged in 13 v_1 progressions. The 4 most intense progressions designated by a(v), b(v), c(v) and d(v) are given the following assignments: a(v), very strong, $(v00) \rightarrow (000)''$; b(v), strong, $(v10) \rightarrow (000)''$; c(v), strong, $(v02) \rightarrow (000)''$; and d(v), medium, $(v04) \rightarrow (000)''$. A weak progression designated by m is given the assignment $(v12) \rightarrow (000)''$. The band intervals of any one of these progressions plotted versus v_1' should give a straight line of slope $2x_{11}$. This is observed to be the case above $v_1' = 4$ where the slope is close to -4.88 for all 5 progressions. However, below $v_1' = 4$ the slope is about -6.5 for progressions a and b, while the slope for progressions c, d, and m is approximately -3 at low v_1' . This means that excited state vibrational levels with $v_1' < 4$ are perturbed. The relative values of the peak extinction coefficients have been determined for the bands of the 4 principle progressions. The most intense band of each progression is respectively: a (12), b (11)², c (8), d (3). Condon overlap integrals calculated to the harmonic approximation give maximum intensity in all 4 progressions at the same value of v_1' namely $v_1' = 6$ and 7.

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2099

Texas A. and M. Coll. [Dept. of Physics] College Station.

INTENSITY OF VIBRONIC BANDS IN 3000-5000Å
ABSORPTION SYSTEM OF CHLORINE DIOXIDE (Ab-
stract), by J. K. Ward and C. M. Loyd. [1955] [1]p.
[AF 18(600)439] Unclassified

Presented at meeting of the Amer. Phys. Soc., Mexico
City, Mexico, Aug. 29-31, 1955.

Published in Phys. Rev., v. 100: 963, Nov. 1, 1955.

The Franck-Condon principle relates the relative intensities of the vibronic bands of an absorption system to the change in geometry of the molecule during the associated electronic transition. The vibrational frequencies and the geometry of both ground and excited state of the chlorine dioxide molecule are known. On the basis of this information, the Condon overlap integrals were evaluated to the harmonic approximation, giving theoretical relative intensities for the bands of progressions (a) $(\nu_1'00) \rightarrow (000)$ and (b) $(\nu_1'10) \rightarrow (000)$.

Measurements of the relative intensities of the bands of these progressions were made photographically at several different concentrations and path lengths. A rotating sector was used for plate calibration. About 20 determinations with optical densities of 0.1 to 0.6 were made for each band, avoiding extreme densitometer readings. Background intensities were subtracted. The close agreement between theory and experiment for the (b) progression suggests that the harmonic approximation permits reasonably accurate calculated intensities. For the (a) progression, the experimental intensities are considerably larger, after $\nu_1' = 8$, than those theoretically predicted. This indicates some additional intensity effect.

2100

Texas A. and M. Coll. [Dept. of Physics] College Station.

THE 2000-2400Å ABSORPTION REGION OF SO₂ VAPOR
(Abstract), by J. W. Riggs and J. B. Coon. [1958] [1]p.
[AF 18(600)439] Unclassified

Presented at the Symposium on Molecular Structure and
Spectroscopy, Ohio State U., Columbus, June 19

Duchesne and Rosen have suggested that the vibronic bands of this region belong to several separate electronic transitions. The present paper presents evidence that all these bands belong to a single transition. Spectrograms taken in the 3rd order of a 2-m grating spectrograph show at least 30 partly resolved bands distributed throughout this region which show similar structure. These bands exhibit q and r branches degrading to the red with a 2nd difference corresponding to $\Delta(\bar{A}-\bar{B}) \approx -0.70 \text{ cm}^{-1}$. Each sub-band is characterized by a

sharp intensity peak which is probably a Q branch. For most bands a weak subhead extends $8-14 \text{ cm}^{-1}$ toward the violet side of the principal head. Interpretation of these subheads in terms of R branches leads to $\Delta\bar{B} \approx -0.01 \text{ cm}^{-1}$. These results indicate a fairly large increase in band distance and a significant decrease of angle. This corresponds to Walsh's predictions for a ${}^1B_1 \rightarrow {}^1A_1$ transition in this region. The large change in geometry indicated by the rotational structure is consistent with the interpretation that the corresponding band system extends over a considerable wavelength range. Although the bands have sharp heads which can usually be isolated from each other, the system resists interpretation in terms of symmetrical frequencies alone. Some progress is being made in the vibrational analysis by assuming that bands involving the antisymmetrical mode appear because of a double minimum potential in the antisymmetrical coordinate.

2101

Texas A. and M. Coll. Dept. of Physics, College Station.

THE ELECTRONIC SPECTRA OF SIMPLE MOLECULES, by J. B. Coon. Final rept. Dec. 17, 1959, 24p. incl. tables, refs. (AFOSR-TR-59-206) (AF 18(600)-439) AD 232660; PB 145837 Unclassified

An examination is made of the possible methods for obtaining information about excited electronic states of simple molecules from a study of their ultraviolet absorption spectra. Examples are given to illustrate that the moments of inertia of the excited states of simple molecules may be determined from incompletely resolved band envelopes. A method of applying the Franck-Condon principle to the determination of the geometry of the excited state of a molecule is outlined and an illustration is worked out. A study of the vibrational structure of several vibronic band systems not only yields excited state vibrational constants, but also indicates that double minimum potential functions occur frequently in excited electronic states. A 2 parameter double minimum potential function was set up and its wave functions and energy levels were determined. With the aid of this model function observed energy levels or band intensities led to the determination of a double minimum potential function of a molecule. Several applications for observed energy levels are given. (Contractor's abstract)

2102

Texas A. and M. Coll. [Dept. of Physics] College Station.

A DOUBLE MINIMUM POTENTIAL FUNCTION
(Abstract), by N. W. Naugle, J. R. Henderson, and J. B. Coon. [1959] [1]p. [AF 18(600)439] Unclassified

Presented at meeting of the Amer. Phys. Soc., Texas U., Austin, Mar. 6-7, 1959.

AIR FORCE SCIENTIFIC RESEARCH

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 105, Mar. 6, 1959.

Recent literature suggests that frequently an excited electronic state of a molecule has a potential function with a double minimum in 1 of the antisymmetrical normal coordinates. Such a potential function may be described approximately by $V = (1/2)\lambda Q^2 + A \exp[-(e^{3/2}\lambda/2A)Q^2]$. The coefficient of the exponent is determined by requiring that the 2 minima be parabolic. Using machine calculations the low-energy levels and the corresponding wave functions of this potential have been obtained in a dimensionless form applicable to any double minimum problem. A linear combination of the first 12 harmonic oscillator wave functions corresponding to the potential $\frac{1}{2}\lambda Q^2$ is used as a variation function. This approach is appropriate for low potential barriers. The secular determinant is solved by the Jacobi method. As an example, the barrier height in the out-of-plane bending coordinate of the 1A_2 state of formaldehyde, as determined from the observed levels, is 550 cm^{-1} for H_2CO and 490 cm^{-1} for D_2CO . The wave functions will permit calculation of band intensities.

2103

Texas A. and M. Coll. [Dept. of Physics] College Station.

THE DOUBLE MINIMUM POTENTIAL OF H_2CO (Abstract), by N. W. Naugle, J. R. Henderson, and J. B. Coon. [1959] [1]p. [AF 18(600)439] Unclassified

Presented at the Symposium on Molecular Structure and Spectroscopy, Ohio State U., Columbus, June 1959.

The energy levels and wave functions have been obtained for a convenient double minimum potential function with 2 parameters. The problem has been solved in dimensionless form so as to be applicable to any double minimum problem. As a test case the 0^+ , 1^+ , and 1^- levels known for NH_3 lead to a barrier height within 5%, and a displacement of the N atom from the H plane within 10%, of the known values. For the low barrier of H_2CO the present method is expected to give better results than for the high barrier of NH_3 . The barrier height B and the angle Θ_m of out-of-plane bending, are determined for the 1A_2 electronic state of H_2CO and D_2CO using values of the 0^+ , 0^- , and 1^+ levels given by Robinson. The results are $B(\text{H}_2\text{CO}) = 379 \text{ cm}^{-1}$, $B(\text{D}_2\text{CO}) = 376 \text{ cm}^{-1}$, $\Theta_m(\text{H}_2\text{CO}) = 30^\circ.94$, and $\Theta_m(\text{D}_2\text{CO}) = 31^\circ.16$. If the 1^- level is given a weight equal to that of the other levels a barrier more than 100 cm^{-1} higher is obtained. However, it is reasonable

that the lower levels should lead to the best barrier height. The levels 0^+ , 0^- , and 1^+ known³ for the 3A_2 state of H_2CO lead to a barrier height $B = 793 \text{ cm}^{-1}$ and a bending angle $\Theta_m = 40^\circ.0$.

2104

Texas A. and M. Coll. Dept. of Physics, College Station.

SPIN-LATTICE RELAXATION TIMES IN BINARY SOLUTIONS, by R. W. Mitchell and M. Eisner. Mar. 1959 [35]p. incl. diagrs. tables. (AFOSR-TN-59-286) (AF 18-(600)1300) AD 212919; PB 140813 Unclassified

Spin-lattice relaxation time (T_1) measurements in binary mixtures at 43 gauss are presented. The results are compared to the predictions of the Debye model as well as other models. The method of measuring T_1 consists of establishing an initial magnetization of a sample in a magnetic field, and then suddenly changing the magnetic field to a new value. T_1 is calculated from the growth or decay of the z component of the nuclear magnetic moment of the sample. The z component of the magnetic moment is determined by the amplitude of the resonance absorption signal from the sample. Results for solutions in CS_2 show that $\frac{1}{\eta T_1}$ is not a linear function of concentration even in cases where there is no association. It is concluded that deviations of $\frac{1}{\eta T_1}$ from linearity do not mean of necessity that the solution is associated. The fact that $\frac{1}{T_1}$ plotted against mol fractions is a linear function suggests that the rotational and translational motions are closely related and that diffusion is accompanied by tumbling. The extrapolation of the relaxation times to infinite dilutions yield rotational correlation times which are in good agreement with the Hill theory. The correction of the translatory diffusion by the Hill theory leads to the best internal consistency and underscores the fact that in solutions the interaction of the molecules with its surroundings is best given by a microscopic viscosity, rather than a macroscopic viscosity. (ASTIA abstract)

2105

Texas U. [Dept. of Chemistry] Austin.

INTERACTIONS OF ACETYLENE AND AROMATIC HYDROCARBONS, by R. C. Anderson and R. S. Wallace. June 1959 [13]p. incl. diagr. tables. (Technical note no. 5) (AFOSR-TN-59-611) (AF 18(603)142) AD 217398; PB 143298 Unclassified

The earlier experiments of F. C. Stehling (Ph.D. Dissertation, Texas U., 1957) on thermal reactions of

AIR FORCE SCIENTIFIC RESEARCH

mixtures of acetylene with aromatic hydrocarbons have been extended to styrene-acetylene mixtures at temperatures of 600-800°C. The data are limited because of the high rate of polymerization of styrene, but they do offer a useful comparison with other hydrocarbon systems because styrene is a very reactive compound. Styrene was found to be quite reactive in polymerization even in gas phase at low pressure. Like the other aromatic hydrocarbons, however, it showed little decomposition up to 800°. With acetylene present, small amounts of addition products were observed; but the chief effects with all the hydrocarbons tested were increased production of decomposition products such as hydrogen and methane. The results indicate that acetylene supplies an activated molecule or diradical which can react so as to open or split the aromatic ring structure. (Contractor's abstract)

2106

Texas U. [Dept. of Chemistry] Austin.

DECOMPOSITION OF VINYLACETYLENE AND DIACETYLENE AND THEIR INTERACTION WITH ACETYLENE, by J. D. Frazee and R. C. Anderson. Aug. 1959, 39p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-59-934) (AF 18(603)142) AD 228537; PB 144384 Unclassified

As in the case of the aromatic compounds, methane is formed readily and early in reaction. Diacetylene is notable for the fact that methane was not detectable in its decomposition products. (Contractor's abstract)

2107

Texas U. [Dept. of Physics] Austin.

ANNIHILATION OF POSITRONS IN ORGANIC LIQUIDS, by C. R. Hatcher, T. W. Falconer, and W. E. Millett. [1959] [4]p. incl. diagrs. tables. (AFOSR-TN-59-90) (AF 33(038)20681) AD 233951 Unclassified

Presented at meeting of the Amer. Phys. Soc., Texas U., Austin, Mar. 6-7, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 100, Mar. 6, 1959.

Also published in Jour. Chem. Phys., v. 32: 28-31, Jan. 1960.

The mean life τ_2 and fraction I_2 of positrons which form ^3S positronium were measured for annihilation in 20 organic liquids—alcohols, glycols, acids, benzene derivatives and others. By using the measured value of τ_2 , it is possible to calculate $\langle\sigma v\rangle_{\text{Av}}$ where σ is the molecular cross section for annihilating ^3S positronium on collision and v is the velocity of the positronium atom. The results show that in general $\langle\sigma v\rangle_{\text{Av}}$ is re-

lated to the size of the molecule although there are some consistent exceptions to this rule. There is also a rough correlation between τ_2 and density, τ_2 being shortest for the most dense liquids and longest for the least dense ones. (Contractor's abstract)

2108

[Texas U. Dept. of Physics, Austin].

PRECISION THERMOMETER SYSTEM FOR THE LIQUID HELIUM SYSTEM, by B. J. Sandlin and J. C. Thompson. [1959] [3]p. [AF 33(636)20681]

Unclassified

Published in Rev. Scient. Instr., v. 30: 659-671, Aug. 1959.

This system uses a carbon resistor (Allen-Bradley type) as the sensing element. The resistor is in the frequency determining circuit of a stabilized Wien bridge oscillator. Thus temperature changes are displayed as frequency shifts. The frequency is read directly from a Hewlett-Packard type 523 B counter. When operated in the neighborhood of 100 kc/sec at 4.2°K the sensitivity is approximately 50 kc/sec/°K. This corresponds to a temperature resolution of 20μ°, when used with the above counter. Resolution can be improved by observing higher harmonics. The power input to the resistor is of the order of 10^{-2} μW. The time for a temperature measurement is 1 sec, and response times to changes are limited only by equilibrium in the thermometer. Absolute accuracy is essentially limited only by the determination of the helium vapor pressure during calibration.

2109

Texas U. Dept. of Physics, Austin.

EFFECTS OF HIGH PRESSURE ON THE NEAR ULTRAVIOLET VAPOR ABSORPTION SPECTRUM OF BENZENE IN A NUMBER OF DILUENT GASES, by S. E. Babb, Jr., J. M. Robinson, and W. W. Robertson. [1959] [30]p. incl. diagrs. table, refs. (AFOSR-TN-59-22) (AF 49(638)35) AD 208752 Unclassified

Also published in Jour. Chem. Phys., v. 30: 427-434, Feb. 1959.

The absorption spectrum of benzene vapor in a number of gaseous diluents over a wide range of diluent densities has been obtained. The wave length of absorption shifts to the red in the gases A, H₂, N₂, CO₂, O₂, CO, C₂H₆ and C₂H₄, to the blue in the diluents He and Ne. Since the light absorber is the same in each case, the relative rates of shift with density should be a function of the physical properties of the diluents. However, no simple correlation has been found to exist between

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relative shift and such properties of the solvents as polarizability or dielectric constant. Dispersion theory predicts only roughly the relative shifts. No satisfactory explanation has been found for the blue shift obtained in He and Ne. (Contractor's abstract)

2110

Texas U. Dept. of Physics, Austin.

THE RELATIVE INTENSITIES OF ABSORPTION BANDS IN LIQUID AND GAS PHASES FROM DISPERSION THEORY, by E. E. Ferguson. [1959] 6p. (AFOSR-TN-59-287) (AF 49(638)35) AD 213031

Unclassified

Also published in Jour. Chem. Phys., v. 30: 1059-1060, Apr. 1959.

The well-known expression for the ratio of liquid-gas intensities of absorption bands is derived from the point of view of dispersion theory which shows clearly several assumptions implicit in the expression, the most important being the restriction to weak bands. The manner in which liquid and gas oscillator strengths can be determined from liquid dispersion data is discussed and the infrared dispersion data of CS₂ is analyzed in this way. (Contractor's abstract)

2111

Texas U. Dept. of Physics, Austin.

SPECTROSCOPIC EVIDENCE FOR LONG-RANGE REPULSIVE INTERMOLECULAR FORCES, by W. W. Robertson and A. D. King, Jr. [1959] [16]p. incl. diagrs. table, refs. (AFOSR-TN-59-688) (AF 49(638)35) AD 219402; PB 143021

Unclassified

Also published in Jour. Chem. Phys., v. 31: 473-476, Aug. 1959.

Experimental results are presented on the shift of wavelength of absorption of benzene, naphthalene, pyrene and phenanthrene with density of the diluents helium and nitrogen. Arguments are presented to show that the blue shift observed in the ¹L_b spectrum in helium is neither due to short-range repulsive forces nor to long-range dispersive forces. It is presumed that there are weak, long-range, nondispersive forces present in the benzene-helium interaction that have the character of repulsive forces. (Contractor's abstract)

2112

Texas U. Dept. of Physics, Austin.

VIBRATION PERTURBATIONS IN ELECTRON-

ICALLY EXCITED MOLECULES, by C. E. Weigang, Jr. and W. W. Robertson. [1959] [5]p. incl. diagrs. table, refs. (AF 49(638)35)

Unclassified

Presented at meeting of the Phys. Chem. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 134th meeting of the Amer. Chem. Soc., Abstracts of Papers, 1958, p. 46-S.

Also published in Jour. Chem. Phys., v. 30: 1413-1417, June 1959.

Small vibration shifts of usually 10 to 50 cm⁻¹ can be observed superimposed on the electronic shifts of 200 to 1000 cm⁻¹ which occur on solvation of aromatic polynuclear hydrocarbons. Vibration assignments for benzene indicate that the observed behavior of its vibration bands is due to the perturbation of a single vibration in the electronically excited benzene molecule. The change corresponds to an increase of frequency for the excited state E_g⁺ 3080-cm⁻¹ C-H vibration. A similar phenomenon can be detected in the naphthalene spectrum. The results are compared to the recent work of Fishman, Beeson, Wiederkehr, and Drickamer on pressure perturbations of vibrations in electronic ground state molecules in solution. (Contractor's abstract)

2113

Texas U. Dept. of Physics, Austin.

INFRARED DISPERSION DUE TO THE ASYMMETRIC STRETCHING VIBRATION OF CS₂, by E. E. Ferguson and R. E. Kagarise. [1959] [3]p. incl. refs. (AF 49(638)35)

Unclassified

Published in Jour. Chem. Phys., v. 31: 236-238, July 1959.

Infrared dispersion data on liquid CS₂ in the wavelength range 2-15μ have been analyzed according to classical dispersion theory to yield both gas and liquid oscillator strengths for the asymmetric stretching vibration. The calculated gas intensity for this vibration is 7000 x 10¹⁰ cm⁻¹ sec⁻¹ (STP) as compared to directly measured values around 7500 x 10¹⁰. The intensity of the bending vibration of CS₂ which has not yet been measured is inferred to be 275 x 10¹⁰ cm⁻¹ sec⁻¹. The CS bond dipole moment is calculated to be 1.24 debye which gives a quadrupole moment in reasonable agreement with experiment. (Contractor's abstract)

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2114

Texas U. [Dept. of Psychology] Austin.

THE INHIBITION OF AGGRESSION UNDER NON-ARBITRARY FRUSTRATION, by P. Rothaus and P. Worchel. [1959] [10]p. incl. tables, refs. (AFOSR-TN-59-989) (AF 49(638)460) AD 238651

Unclassified

Also published in Jour. Personality, v. 28: 108-117, Mar. 1960.

The present study was designed to test the hypothesis that the reduction of hostile responses under reasonable or nonarbitrary frustration is due to the inhibitions aroused by the nature of the social situation. In addition, it was proposed to investigate the relationship of sex and the discrepancy between self and ideal concepts to the expression of aggression under different degrees of arbitrariness of frustration. The results showed: (1) The 218 subjects under an arbitrary set of frustration reported significantly greater hostile feelings, actions, and percentage of actions to feelings than those under the nonarbitrary frustration. (2) The subjects under the projective nonarbitrary frustration reported significantly greater number of hostile feelings, actions, and percentages of actions to feelings than those under the nonarbitrary frustration. (3) Though there was no significant difference between the sexes in the number of hostile feelings, the males reported greater hostile actions and percentage of hostile actions to feelings than did the females. (4) On both actions and percentage, subjects with high self-ideal discrepancy reported significantly higher hostility than those with low self-ideal discrepancy. (5) On feeling, however, the significant triple interaction showed that under arbitrary frustration, males with low self-ideal (SI) discrepancy reported higher hostile feelings than those with high discrepancy. For the females under the same condition, it was the reverse; that is, those with high SI discrepancy reported more hostile feelings than those with low discrepancy. Under nonarbitrary conditions, all the subjects with high SI discrepancy, on the average, reported more hostile feelings than those with low discrepancy. (Contractor's abstract)

2115

Thiokol Chemical Corp. Reaction Motors Div., Denville, N. J.

IONS IN ROCKET COMBUSTION PRODUCTS (Abstract), by R. W. Ellison. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)305)

Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

Two phases of this research are discussed: (1) the

possibility of steering a missile in powered flight by electric fields, and (2) the concentrations of ions that are available in rocket chambers and exhausts. An ionization of at least 0.1% in a rocket exhaust is shown to be of interest in the application of electric fields to produce useful macroscopic effects. An example based on electric steering is derived for a simple no collision model and compared with a calculation recognizing collisions. The significance of fringing fields is discussed. Experimental data on the ionization in rocket chambers and exhausts are presented for hydrogen-oxygen combustion and for a flame salted with cesium compounds. The experimental results are compared with calculated ion concentrations, and some new theoretical results are shown to illustrate the effects of combustion pressure on salted flames and the influence of various percentages of alkali-earth additive on ion concentrations.

2116

Thiokol Chemical Corp. Reaction Motors Div., Denville, N. J.

HEAVY PARTICLE PROPULSION RESEARCH (Abstract), by R. E. Wiech, Jr. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) (AF 49(638)657)

Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

The objectives of this program are to conduct basic studies on the possibility of using heavy particles of micron dimensions as the working fluid in an ion propulsion system. The problem areas under investigation are: (1) particle generation; (2) particle ionizing (charging); (3) control and acceleration; and (4) measurement. A literature search has been undertaken to cover these areas. Related fields, such as air pollution studies, precipitators, etc., are proving to be the best sources of information on charged particles. Various charging methods are available which include combustion, friction, direct charging, radiation, interface effects and other similar systems. The various charging mechanisms are discussed. Aluminum flow rates of approximately 0.1 g/sec were recorded. The flow rate was found to be sensitive to particle size and electric field gradient. The particles emerge from the charging unit with a velocity of several hundred cm/sec.

2117

Toronto U. Inst. of Aerophysics (Canada).

PRESSURE PROBES IN FREE MOLECULE FLOW, by K. R. Enkenhus, E. L. Harris, and G. N. Patterson. June 1959 [18]p. incl. diagrs. (UTIA rept. no. 62) (AFOSR-TR-59-120) (AF 18(600)1185) AD 240553

Unclassified

AIR FORCE SCIENTIFIC RESEARCH

When the mean free path becomes a significant fraction of a characteristic dimension of a pressure probe, the continuum formulae relating the measured pressure to the free-stream pressure and Mach number are no longer valid. The case is treated where the mean free path is so large compared with the probe diameter that intermolecular collisions may be neglected. This is the condition for free molecule flow. Theoretical expressions are given for the pressure measured in a flowing gas with an orifice probe and a long-tube pressure probe. Experimental investigations were conducted using a low-density wind tunnel and a rotating-arm apparatus. Agreement between theory and experiment was quite satisfactory. (Contractor's abstract)

2118

Toronto U. Inst. of Aerophysics (Canada).

AN EXPERIMENTAL INVESTIGATION OF THE NOISE GENERATED BY THE TURBULENT FLOW AROUND A ROTATING CYLINDER, by L. N. Wilson. Apr. 1959 [73]p. incl. illus. diagrs. refs. (UTIA rept. no. 57) (AFOSR-TN-59-487) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)249 and Canadian Defence Research Board) AD 228504

Unclassified

Also published in Jour. Acoust. Soc. Amer., v. 32: 1203-1207, Oct. 1960.

The near and far field noise from the turbulent boundary layer developed on a rotating cylinder was studied; both smooth and artificially roughened surfaces were employed. The cylinder walls were sufficiently thick to inhibit appreciable boundary-layer excited vibration noise. The mean square pressure followed a U_0^4 law in the near field, and approximated a U_0^6 law, as did the acoustic power, in the far field. Drag calculations from hot wire measurements allowed an estimate of the efficiency (acoustic power/mechanical power) of the far field radiation, resulting in an efficiency about 10 times that for the quadrupole radiation from a jet at a Mach number of .228. Even so, the measured noise power from the boundary layer over a rigid wall appears to be relatively small in any practical application to the noise in aircraft. (Contractor's abstract)

2119

Toronto U. Inst. of Aerophysics (Canada).

THE SOUND GENERATED BY INTERACTION OF A SINGLE VORTEX WITH A SHOCK WAVE, by H. S. Ribner. June 1959 [20]p. incl. illus. diagrs. (UTIA rept. no. 61) (AFOSR-TN-59-1166) (AF 49(638)249) AD 230719

Unclassified

Presented at 1959 Heat Transfer and Fluid Mechanics Inst., Calif. Inst. of Tech., June 19-21, 1957.

The passage of a columnar vortex broadside through a shock is investigated. The vortex is decomposed (by Fourier transform) into plane sinusoidal shear waves disposed with radial symmetry. The plane sound waves produced by each shear wave-shock interaction, known from previous work, are recombined in the Fourier integral. The waves possess an envelope that is essentially a growing cylindrical sound wave, partly cut off by the shock. The sound wave is centered at the transmitted (and modified) vortex and the peak pressure attenuates inversely as the square root of the growing radius. The strength varies smoothly around the arc, from compression at one shock intersections to rarefaction at the other shock intersection. (Contractor's abstract)

2120

Toronto U. Inst. of Aerophysics (Canada).

RECENT TRENDS IN THE MECHANICS OF HIGHLY RAREFIED GASES, by G. N. Patterson. Jan. 1960 [39]p. incl. illus. diagrs. table, refs. (UTIA review no. 16) (AFOSR-TN-59-790) [AF 49(638)281] AD 241337

Unclassified

Also published in Proc. Durand Centennial Conf. on Aeronaut. and Astronaut., Stanford U., Calif. (Aug. 6-8, 1959), New York, Pergamon Press, 1960, p. 122-152. (AFOSR-TR-59-108)

A review of some recent investigations in the flow of highly rarefied gases is presented. The basic nature of the transport process in free molecule flow is deduced from the Boltzmann equation for the molecular velocity distribution function. The present semi-empirical state of our knowledge of the reflection of molecules from the surface of a solid is summarized, and some directions for research are indicated. The aerodynamic properties of bodies in highly rarefied flows is considered with emphasis on the long cylinder as a case of special interest. The theory is extrapolated to the limit of very high speed ratios or Mach numbers, and the results are compared with those deduced from the Newtonian flow theory. The application of recent studies of rarefied gas flows to the development of instruments for the measurement of the pressure, temperature and density of such flows is reviewed in some detail. The use of free molecule probes for the study of boundary layers and shock waves is outlined. The review is brought to a close with a very brief consideration of some factors involved in the collision-free flow of a plasma. (Contractor's abstract)

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2121

Training Center for Experimental Aerodynamics,
Brussels (Belgium).

EXPERIMENTAL EVIDENCE OF THREE-DIMENSIONAL PERTURBATIONS IN THE REATTACHMENT OF A TWO-DIMENSIONAL LAMINAR BOUNDARY LAYER AT $M = 2.05$, by J. J. Ginoux. Nov. 1958 [31]p. incl. illus. diagrs. refs. (Technical note no. 1) (AFOSR-TN-59-169) (AF 61(514)993) AD 211148; PB 140235 Unclassified

The reattachment of a laminar boundary-layer after separation was investigated at a Mach number of 2.05. Backward facing step models were used that completely spanned the working section. Surface flow was observed by a sublimation technique, and detailed span-wise surveys were made in the reattachment region of the flow with total head probes. Strong, regular and repeatable span-wise perturbations were observed which could not be explained by irregularities either in the airflow upstream of the models or in the models themselves. This document includes an appendix entitled: Axial Vorticity in Steady Ideal Fluid Flow, by J. Smolderen.

2122

Trinity Coll., Hartford, Conn.

CONTRIBUTIONS TO THE THEORY OF CHARACTERISTIC FUNCTIONS OF THE DIFFERENTIAL OPERATOR $z^N - d^2/dz^2$, by W. J. Klimczak. Dec. 31, 1958, 6p. (AFOSR-TR-59-2) (AF 18(600)1397) AD 261904 Unclassified

Research is summarized on certain aspects of the theory of series of the form $f(z) = \sum_{n=0}^{\infty} f_n w_n(z)$, where z is a complex variable and the $w_n(z)$ are characteris-

tic functions of the differential operator $\delta_z = z^N - d^2/dz^2$, N being a positive integer.

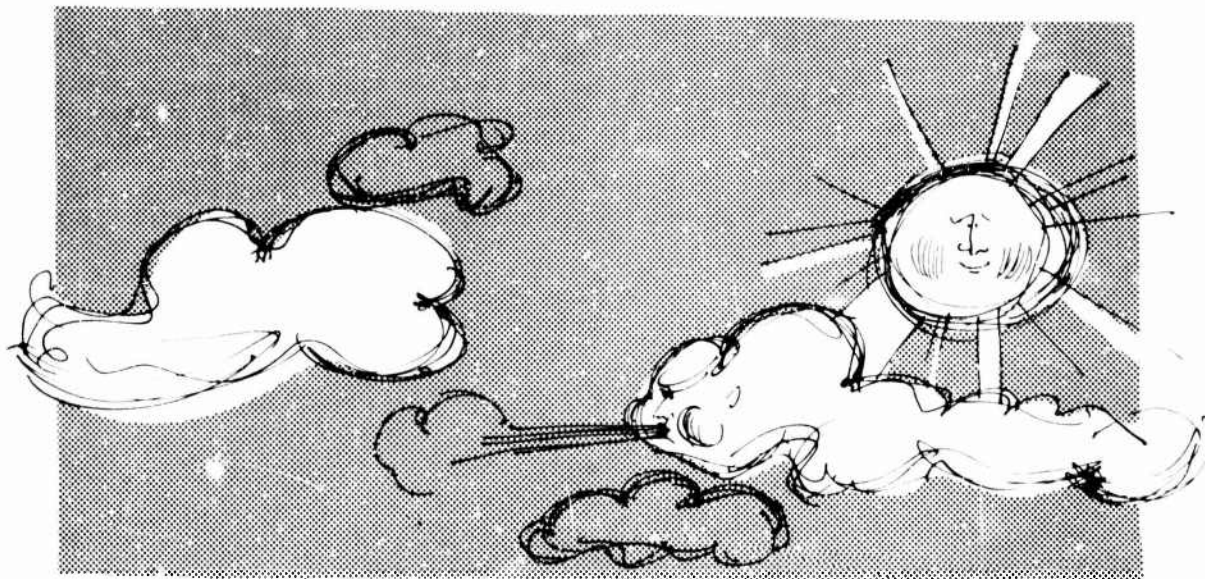
2123

Tufts U. Dept. of Chemistry, Medford, Mass.

INITIAL REACTION INTERMEDIATES IN THE OZONATION OF ALKENES, by A. A. Santilli and F. L. Greenwood. [1959] [40]p. incl. diagrs. refs. (AFOSR-TN-59-903) (AF 49(633)292) AD 244737

Unclassified

The reactions of 3-octene, 3-hexene, 2-methyl-2-pentene and 2,3-dimethyl-2-butene in n-pentane at -75° with equivalent amounts of ozone are described. The reactions of the last 3 olefins in methanol at -75° with equivalent amounts of ozone also have been studied. Apparatus was constructed which permitted taking the infrared spectra of these cold, ozonized solutions before allowing the reaction solutions to warm. Identification of molecular species present in the cold ozonized solutions permitted us to distinguish between heat cleavage and ozonation cleavage products. Three previously unreported products, 3-octene ozonide, 2-methyl-2-pentene ozonide and 1-hydroperoxypropyl methyl ether were prepared and characterized. The spectral results can best be interpreted by assuming the formation of a very reactive initial ozonide as the 1st product in each of the above reactions. The initial ozonide of each olefin is apparently unstable even at -75° in both n-pentane and methanol and decomposes to form a peroxidic zwitterion and carbonyl compound. Evidence is presented for the formation of the zwitterion and carbonyl compound. The final products are formed when these species react chemically with each other or the solvent or undergo self condensation. The conclusion is that the products reported in the text do, indeed, result from ozone cleavage and not from heat decomposition or rearrangement during the workup procedure. (Contractor's abstract)



AIR FORCE SCIENTIFIC RESEARCH

Universita di Roma (Italy) see
Rome U. (Italy).

Université Libre de Bruxelles (Belgium) see
Free U. of Brussels (Belgium).

2124

Uppsala U. Gustaf Werner Inst. for Nuclear Chemistry
(Sweden).

RESEARCH ON "LOCALIZED RADIO-LESIONS."
PART II. EFFECT OF HIGH ENERGY PROTONS ON
THE BRAIN OF THE RABBIT, by B. Rexed, W. Mair
and others. May 1, 1959 [16]p. incl. illus. (Technical
rept. no. 1) (AFOSR-TN-59-976) (AF 61(514)1247)
AD 226389; PB 143586 Unclassified

Also published in *Acta Radiol.*, v. 53: 289-299, 1960.

The effect of irradiation by 185 mev proton beam on the
central nervous system was investigated. The upper
anterior part of the brain of rabbits was irradiated with
a beam 1.5 mm broad and a dose of 20,000 rad. A well-
defined lesion occurred and was confined to the path of
the beam for a period up to 3 mo and slightly wider
than the beam at subsequent periods after irradiation.
The histological change following irradiation at inter-
vals from 2 to 56 wk are presented. Destruction of
nerve cells, myelin sheaths and axons was evident.
Thick walled capillaries, small perivascular hemor-
rhages and macrophages appeared in the early stages
of the lesion. Proliferation of astrocytes occurred.
Astrocytes with nuclei 3 or 4 times the normal size
appeared at 4 wk and subsequently giant cells with 1 or
more nuclei were frequently seen, always within the
irradiated region. Ten wk after irradiation small cav-
ities occurred in some animals. Large thin walled
capillaries were seen at 23 wk and all later periods up
to 1 yr after irradiation. No large hemorrhages were
ever seen.

2125

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF Ni_{12}P_5 , by S.
Rundqvist and E. Larsson. Nov. 22, 1958 [12]p.
incl. diagrs. tables, refs. (Technical note no. 4)
(AFOSR-TN-59-35) (AF 61(052)40) AD 209207
Unclassified

Also published in *Acta Chem. Scand.*, v. 13: 551-560,
1959.

The crystal structure of Ni_{12}P_5 has been determined
with single-crystal methods. The unit cell, containing
2 formula units, is tetragonal, $a = 8.646 \text{ \AA}$; $c = 5.070 \text{ \AA}$.

The space group is $I 4/m - (C_{4h}^5)$ with 16 Ni in 16(i):

$x = 0.116_0$; $y = 0.182_2$; $z = 0.248$; 8 Ni in 8(h): $x = 0.368$;
 $y = 0.060$; 8 P in 8(h): $x = 0.195$; $y = 0.415$; and 2 P in
2(a). A comparison of Ni_{12}P_5 with related structures
is made. Some phase-analytical observations in the
Ni-P system are reported. NiP_3 is cubic, $a = 7.819 \text{ \AA}$;
and isostructural with CoP_3 . $a = 7.706 \text{ \AA}$. Both NiP_3
and CoP_3 belong to the D_2 (CoAs_3) structure type.
(Contractor's abstract)

2126

Uppsala U. Inst. of Chemistry (Sweden).

RESEARCH ON METALLIC PHASES IN SYSTEMS OF
TRANSITION METALS WITH NON-METALS, by G.
Nag. Annual technical summary rept. no. 1, Dec. 31,
1958, 6p. incl. tables. (AFOSR-TN-59-225) (AF 61-
(052)40) AD 211607; PB 139572 Unclassified

Investigations were made of metallic phases formed in
systems of the 8th group metals with B, Si, and P. The
investigations included the determination of the compo-
sitions and equilibria of binary and ternary phases as
well as studies of their crystal structures. In the Ni-B
system, 2 phases with compositions close to Ni_4B_3
were prepared. The 2-phase regions $\text{Ni}_2\text{B}-\alpha\text{-Ni}_4\text{B}_3$
and $\beta\text{-Ni}_4\text{B}_3\text{-NiB}$ existed between 800° and 1000°C .
The existence of Rh_7B_3 , isostructural with RuB_3 and
with Hexagonal unit cell dimensions, was noted in in-
vestigations of the Rh-B system. The crystal structure
of Ru_2Si was determined. Rh_2Si was found to be iso-
structural with Ru_2Si . The crystal structure of Fe_2P ,
 Mn_2P , and Ni_2P were reexamined. The Fe-P-B ternary
system was studied by x-ray methods. B substituted
for P to a large extent in Fe_2P and Fe_3P , but no exten-
sion of the homogeneity ranges of Fe_2B and FeB was de-
tected. Two ternary phases of Fe_5PB_2 and $\text{Fe}_3\text{B}_x\text{P}_{1-x}$
were found. The Co-B-P and the Mn-B-P systems were
similar to the Fe-B-P system. In the Co-B-P system,
ternary phases isostructural with Fe_3P and with
 $\text{Fe}_3\text{B}_x\text{P}_{1-x}$ ($0.5 < x < 1$) were noted. (ASTIA abstract)

2127

Uppsala U. Inst. of Chemistry (Sweden).

BORIDES AND SILICIDES OF THE PLATINUM METALS,
by B. Aronsson, J. Aselius, and E. Stenberg. July 3,
1959 [5]p. incl. table. (Technical note no. 5) (AFOSR-
TN-59-414) (AF 61(052)40) AD 214561; PB 142971
Unclassified

AIR FORCE SCIENTIFIC RESEARCH

Also published in Nature, v. 183: 1318-1319, May 9, 1959.

X-ray crystallographic studies of Pt metal borides were initiated. Three structure types, tentatively notated as Ru_7B_3 , RhB , and IrB_{1-2} , were determined. Evidence indicated that the Rh_2B phase with C_{23} structure reported by Mooney and Welch (Acta Cryst., v. 7: 49, 1954) might have been Rh_2Si . The alloys were prepared by melting mixtures of the elements (99.7 to 99.8%) in an arc furnace. Crystal structures were determined with single crystal methods while the lattice parameters were obtained from powder photographs. The Ru_7B_3 structure was hexagonal; the space group was $P6_3/mc$ with 2 formula units in the unit cell. The most probable space group of the RhB orthorhombic structure is $Cmcm$. The 4 Rh atoms of the unit cell are situated in 4(c) with $y = 0.167$. The B atoms occupy the 4(b) position. The final R-value of the 45 observed $0kl$ reflexions was 8.9%. The space group for the IrB_{1-2} structure is $I4_1/amd$ with 4 Ir atoms in 4(a). An R-value of 9% was obtained for the 30 observed $h0l$ reflexions with $\sin \theta/x > 0.8$. Intermediate phases of the C_{23} type were found to exist in the Ru-Si and Rh-Si systems.

2128

Uppsala U. Inst. of Chemistry (Sweden).

AN X-RAY INVESTIGATION OF THE NICKEL-BORON SYSTEM. THE CRYSTAL STRUCTURES OF ORTHORHOMBIC AND MONOCLINIC Ni_4B_3 , by S.

Rundqvist. Mar. 14, 1959 [24]p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-59-415) (AF 61(052)40) AD 214562 Unclassified

Also published in Acta Chem. Scand., v. 13: 1193-1208, 1959.

The Ni-B system was investigated with x-ray powder and single-crystal methods in the range Ni_3B -NiB. In addition to the previously known intermediate phases, Ni_3B , Ni_2B and NiB, the existence of 2 other phases, both with the ideal compositions Ni_4B_3 but one orthorhombic and the other monoclinic, was established. The crystal structures of the 2 new phases were determined and refined from single-crystal intensity data. The space group of orthorhombic Ni_4B_3 is $Pnma$; the unit cell contains 16 nickel atoms and 12 boron atoms situated in 4(c) positions. Two-thirds of the boron atoms form infinite zig-zag chains, while one-third have no close boron contacts. There are probably boron vacancies in the structure. The space group of monoclinic Ni_4B_3 is $C2/c$. Sixteen nickel atoms are situated in two 8(f) positions, 8 boron atoms in one

8(f) position and 4 boron atoms in one 4(e) position. All boron atoms are connected in infinite chains. (Contractor's abstract)

2129

Uppsala U. Inst. of Chemistry (Sweden).

AN X-RAY STUDY OF PHOSPHIDES OF THE PLATINUM METALS, by S. Rundqvist. July 29, 1959, 4p. incl. table, refs. (Technical note no. 7) (AFOSR-TN-59-656) (AF 61(052)40) AD 226385; PB 143919 Unclassified

Some phosphides of the platinum metals have been investigated with x-ray powder methods. The earlier crystal structure determinations of Rh_2P , IrP and PtP_2 have been confirmed, and the unit cell dimensions redetermined. In addition, the unit cell dimensions and crystal structure types have been determined for Ru_2P , RuP, RuP_2 , OsP_2 , RhP_3 , IrP₃ and PdP_3 . Ru_2P belongs to the C_{23} (anti- $PbCl_2$) type; RuP to the B_{31} (MnP) type; RuP_2 and OsP_2 to the C_{18} (marcasite) type; RhP_3 , IrP₃ and PdP_3 to the D_2 (skutterdite) type. (ASTIA abstract)

2130

Uppsala U. Inst. of Chemistry (Sweden).

BORIDES OF RHENIUM AND THE PLATINUM METALS. THE CRYSTAL STRUCTURE OF Re_7B_3 , ReB , Rh_7B_3 , $RhB_{1.1}$, $IrB_{1.1}$ AND PtB , by B. Aronsson, E. Stenberg, and J. Aselius. Dec. 15, 1959 [19]p. incl. tables, refs. (Technical note no. 8) (AFOSR-TN-59-1138) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)40 and Swedish Technical Science Research Council) AD 233272; PB 145866 Unclassified

Also published in Acta Chem. Scand., v. 14: 733-741, 1960.

Some features of the binary systems of B with Rh and the Pt metals are reported. Re_7B_3 and Rh_7B_3 are isomorphous with Ru_7B_3 (Th_7Fe_3 (D_{10})-type). The structure of ReB_3 is closely related to those of Mo_2B_5 and W_2B_5 . $RhB_{1.1}$ and PtB crystallize in the anti-NiAs structure, and a phase with the approximate composition $IrB_{1.1}$ is isomorphous with $ThSi_2$ (C_c -type). (Contractor's abstract)

AIR FORCE SCIENTIFIC RESEARCH

2131

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF Pd_3Si , by B.

Aronsson and A. Nylund. Jan. 7, 1960 [15]p. incl. tables, refs. (Technical note no. 9) (AFOSR-TN-59-1269) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)40 and Swedish Technical Science Research Council) AD 233277; PB 146129
Unclassified

Also published in Acta Chem. Scand., v. 14: 1011-1018, 1960.

The crystal structure of Pd_3Si was established from single crystal data. The space-group is Pnma , and there are 4 formula units in the elementary cell which has the dimensions $a = 5.735\text{\AA}$, $b = 7.555\text{\AA}$, and $c = 5.260\text{\AA}$. The 12 palladium atoms are situated in 8 (d) ($x = 0.1810$, $y = 0.0508$, $z = 0.3217$) and 4 (c) ($x = 0.0053$, $z = 0.9036$) positions, and the silicon atoms occupy a 4 (c) position ($x = 0.897_6$, $z = 0.469_6$). Pd_3Si , thus, crystallizes in the cementite (DO_{11}) structure.

The atomic arrangement in Pd_3Si is compared with those in isomorphous phases. (Contractor's abstract)

2132

Uppsala U. inst. of Chemistry (Sweden).

X-RAY INVESTIGATION ON RHODIUM PHOSPHIDES. THE CRYSTAL STRUCTURE OF Rh_4P_3 , by S.

Rundqvist and A. Hede. Jan. 9, 1960 [17]p. incl. diagrs. tables, refs. (Technical note no. 10) (AFOSR-TN-59-1270) (AF 61(052)40) AD 233278; PB 145860
Unclassified

Also published in Acta Chem. Scand., v. 14: 893-902, 1960.

The rhodium-phosphorus system was investigated in the range 0-75 at. % phosphorus using x-ray and chemical analytical methods. Four intermediate phases were found, viz. Rh_2P , Rh_4P_3 , RhP_2 and RhP_3 . The structure of Rh_2P is of the anti-fluorite ($\text{C} 1$) type, $a = 5.498\text{\AA}$, and RhP_3 of the skutterudite ($\text{D} 2$) type, $a = 7.996\text{\AA}$. The crystal structure of Rh_4P_3 was determined and refined by single-crystal x-ray methods. The space group is Pnma , $a = 11.562\text{\AA}$; $b = 3.317\text{\AA}$; $c = 9.994\text{\AA}$, and the unit cell contains 16 rhodium atoms and 12 phosphorus atoms on seven 4(c) positions. The structure is related to the Fe_2P ($\text{C} 22$) and Co_2P ($\text{C} 23$) structures. (Contractor's abstract)

2133

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF Re_3B , by B.

Aronsson, M. Bäckman, and S. Rundqvist. Jan. 22, 1960 [9]p. incl. diagr. tables. (Technical note no. 11) (AFOSR-TN-59-1290) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)40 and Swedish Technical Science Research Council) AD 233279; PB 145859
Unclassified

Also published in Acta Chem. Scand., v. 14: 1001-1005, 1960.

The crystal structure of Re_3B was determined by powder and single crystal methods. The dimensions of the orthorhombic unit cell are $a = 2.890\text{\AA}$, $b = 9.313\text{\AA}$ and $c = 7.258\text{\AA}$ ($\pm 0.05\%$). There are 4 formula units in the elementary cell, and the space-group is Cmcm . The 12 rhenium atoms are situated in an eightfold position 8(t) ($y = 0.1345$, $z = 0.0620$) and a fourfold position 4(c) ($y = 0.4262$). From space considerations it was concluded that the boron atoms are also situated in a 4(c) position ($y \sim 0.744$). (Contractor's abstract)

2134

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $\text{SeOCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$, by

G. Nahrnigbauer and I. Lindqvist. Dec. 20, 1958 [17]p. incl. diagrs. tables, refs. (Technical note no. 2) (AFOSR-TN-59-64) (AF 61(052)43) AD 209608; PB 138710
Unclassified

Also published in Acta Cryst., v. 12: 638-642, Sept. 10, 1959.

The crystal structure of the addition compound $\text{SeOCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$ has been determined and refined using 3-dimensional x-ray data. The crystal consists of molecules in which the coordination polyhedron around the central selenium atom is a tetragonal pyramid. The 2 chlorine atoms and the 2 nitrogen atoms of the pyridine rings are bonded in the basal plane with atoms of the same kind in trans positions. The oxygen atom occupies the apex of the pyramid. The molecules show a certain tendency to secondary dimerization over weak chlorine bridges. The bridging chlorine atom completes the distorted octahedron around the central selenium at a distance of 3.64Å. The nature of the chemical bonds and the problem of chloride ion transfer processes in solutions of pyridine in selenium oxychloride are briefly discussed. (Contractor's abstract)

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Uppsala U. [Inst. of Chemistry] (Sweden).

ADDITION COMPOUNDS OF ANTIMONY CHLORIDES WITH SULFOXIDES AND SULFONES, by I. Lindqvist. Oct. 20, 1958 [11]p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-59-116) (AF 61(052)43) AD 210421; PB 133712 Unclassified

Also published in Acta Chem. Scand., v. 13: 420-424, 1959.

The liquidus curves have been studied for the systems $\text{SbCl}_5\text{-SO}(\text{CH}_3)_2$, $\text{SbCl}_5\text{-SO}_2(\text{CH}_3)_2$, $\text{SbCl}_3\text{-SO}(\text{CH}_3)_2$ and $\text{SbCl}_3\text{-SO}_2(\text{CH}_3)_2$. The following new compounds have been prepared: $\text{SbCl}_5\text{-SO}(\text{CH}_3)_2$, $\text{SbCl}_5\text{-SO}(\text{C}_6\text{H}_5)_2$, $\text{SbCl}_5\text{-SO}_2(\text{CH}_3)_2$, $\text{SbCl}_5\text{-SO}_2(\text{C}_6\text{H}_5)_2$, $\text{SbCl}_3\text{-SO}(\text{CH}_3)_2$ and $\text{SbCl}_3\text{-SO}_2(\text{CH}_3)_2$. The melting point relations between these compounds are discussed. (Contractor's abstract)

2136

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $\text{SbCl}_5\text{-POCl}_3$, by I. Lindqvist and C.-I. Brändén. Jan. 12, 1959 [13]p. incl. diagrs. tables, refs. (Technical note no. 3) (AFOSR-TN-59-154) (AF 61(052)43) AD 211114; PB 140399 Unclassified

Also published in Acta Cryst., v. 12: 642-645, Sept. 10, 1959.

The crystal structure of $\text{SbCl}_5\text{-POCl}_3$ has been determined from 3-dimensional x-ray data. This is the first structure determination of an addition compound with an oxychloride functioning as donor molecule. The structure is built up of discrete $\text{SbCl}_5\text{-POCl}_3$ molecules. The coordination around Sb is octahedral with an O atom from POCl_3 in the 6th corner. The approximately tetrahedral structure of POCl_3 is preserved.

The bond angle Sb-O-P is 143.7° . The structure is briefly discussed. (Contractor's abstract)

2137

Uppsala U. Inst. of Chemistry (Sweden).

ADDITION COMPOUNDS OF PHOSPHINE OXIDES, by I. Lindqvist and G. Olofsson. July 17, 1959 [10]p. incl. diagrs. refs. (Technical note no. 4) (AFOSR-TN-59-574) (AF 61(052)43) AD 217021; PB 145620

Unclassified

Also published in Acta Chem. Scand., v. 13: 1753-1757, 1959.

The formation of addition compounds with phosphine oxides as donor molecules has been studied. The following new compounds have been prepared: $\text{SbCl}_5\text{-PO}(\text{C}_6\text{H}_5)_3$, $\text{SbCl}_5\text{-PO}(\text{CH}_3)_3$, $\text{SbCl}_3\text{-PO}(\text{CH}_3)_3$, $\text{SbCl}_3\text{-2PO}(\text{CH}_3)_3$, $\text{AsCl}_3\text{-PO}(\text{CH}_3)_3$, $\text{AsCl}_5\text{-PO}(\text{CH}_3)_3$, (stabilization of AsCl_5), $\text{SeCCl}_2\text{-PO}(\text{CH}_3)_3$, $\text{HgCl}_2\text{-PO}(\text{C}_6\text{H}_5)_3$, $\text{HgCl}_2\text{-PO}(\text{CH}_3)_3$, $5\text{HgCl}_2\text{-2PO}(\text{CH}_3)_3$, and $\text{SO}_3\text{-PO}(\text{C}_6\text{H}_5)_3$. The weak interaction between HgCl_2 and $\text{PO}(\text{C}_6\text{H}_5)_3$ has been revealed by a study of the infrared spectra of the compounds $\text{HgCl}_2\text{-PO}(\text{C}_6\text{H}_5)_3$. (Contractor's abstract)

2138

Uppsala U. Inst. of Chemistry (Sweden).

ADDITION COMPOUNDS OF DIPHOSPHORUS TRI-OXIDE TETRACHLORIDE, by I. Lindqvist, M. Zackrisson, and S. Eriksson. July 17, 1959 [5]p. incl. diagrs. (Technical note no. 5) (AFOSR-TN-59-575) (AF 61(052)43) AD 217022; PB 145619 Unclassified

The formation of addition compounds with diphosphorous trioxide tetrachloride as donor molecule has been studied. The following new compounds have been prepared: $2\text{SbCl}_5\text{-P}_2\text{O}_3\text{Cl}_4$ and $\text{SnCl}_4\text{-P}_2\text{O}_3\text{Cl}_4$, and their infrared spectra have been recorded. (Contractor's abstract)

2139

Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $(\text{TiCl}_4\text{-POCl}_3)_2$, by C.-I. Brändén and I. Lindqvist. Aug. 20, 1959 [12]p. incl. diagrs. tables, refs. (Technical note no. 7) (AFOSR-TN-59-722) (AF 61(052)43) AD 226387; PB 143918 Unclassified

Also published in Acta Chem. Scand., v. 14: 726-732, 1960.

The crystal structure of $(\text{TiCl}_4\text{-POCl}_3)_2$ was determined from 3-dimensional x-ray data. The structure is built up of dimeric molecules $(\text{TiCl}_4\text{-POCl}_3)_2$ with double chlorine-bridges between the 2 titanium atoms of the dimer. The coordination around the titanium atom is octahedral. The oxygen atom in POCl_3 functions as donor atom. The approximately tetrahedral structure of POCl_3 is preserved. The nature of the acceptor-donor interaction in addition compounds where oxychlorides function as donor molecules is discussed. (Contractor's abstract)

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Uppsala U. Inst. of Chemistry (Sweden).

THE CRYSTAL STRUCTURE OF $\text{SnCl}_4 \cdot 2\text{SeOCl}_2$, by Y. Hermodsson. Aug. 20, 1959 [14]p. incl. diagrs. tables, refs. (Technical note no. 6) (AFOSR-TN-59-723) (AF 61(052)43) AD 226386; PB 143636

Unclassified

Also published in Acta Cryst., v. 13: 656-659, 1960.

The crystal structure of the addition compound $\text{SnCl}_4 \cdot 2\text{SeOCl}_2$ has been determined and refined from 3-dimensional x-ray data. The unit-cell dimensions are $a = 9.24 \pm 0.03\text{\AA}$; $b = 9.24 \pm 0.03\text{\AA}$; $c = 16.26 \pm 0.03\text{\AA}$; $\beta = 95^\circ 34' \pm 10'$. There are 4 molecules per unit cell and the space group is $C2/c$. The crystal consists of discrete $\text{SnCl}_4 \cdot 2\text{SeOCl}_2$ molecules. The tin atom is situated on a twofold axis, surrounded by a distorted octahedron of 2 oxygen atoms in *cis*-position and of 4 chlorine atoms. The oxygen atoms form bridges between the tin and the selenium atoms. The SeOCl_2 -parts of the molecules are pyramid-shaped. The angle Sn-O-Se is 121.5° . A tendency to secondary acceptor-donor interaction within and between the adduct molecules can be recognized from the interatomic distances. A distorted octahedral coordination around the selenium atom is obtained, if all nearest neighbors are considered. In this compound selenium oxychloride acts as a donor as well as an acceptor molecule, although the donor action is predominant. (Contractor's abstract)

2141

Uppsala U. Inst. of Physics (Sweden).

A MICROSCOPE FOR THE SCANNING OF NUCLEAR RESEARCH EMULSIONS, by A. G. Ekspong and B. E. Ronne. [1959] [6]p. incl. illus. (AFOSR-TN-59-411) [AF 61(052)13] AD 261902

Unclassified

A microscope which can handle rather large plates is described. The area which can be reached without moving the plate is $25 \times 15 \text{ cm}$. The largest plate which can be examined on the microscope must have one side less than 49 cm . The use of the microscope is made comfortable by suitably constructed manual controls. The stage can be moved rapidly and precisely. (Contractor's abstract)

2142

Uppsala U. Inst. of Physics (Sweden).

ANTIPROTON INTERACTION CROSS SECTIONS, by A. G. Ekspong and B. E. Ronne. [1959] [32]p. incl.

diagrs. tables, refs. (AFOSR-TN-59-412) (Also bound with its AFOSR-TN-58-1077; AD 207456) [AF 61(052)-13, phase A] AD 261903

Unclassified

Also published in Nuovo Cimento, Series X, v. 13: 27-45, July 1, 1959.

Recently obtained antiproton events have been used to obtain interaction cross sections from 371 events of which 340 have been well established to be antiproton annihilation stars. The antiprotons used are in the energy range from 0 to 250 mev, and the events have been analyzed in terms of: annihilation in flight, elastic p-p scattering, elastic and inelastic scattering from complex nuclei, and charge exchange. The mean free path in the emulsion and the cross sections for the various processes are presented.

2143

Uppsala U. Inst. of Physics (Sweden).

Λ^4 HYPERFRAGMENT EMITTED FROM AN

ANTIPROTON CAPTURE STAR, by A. G. Ekspong, A. Frisk, and B. E. Ronne. [1959] [8]p. incl. diagrs. table, refs. (Technical note no. 4) (AFOSR-TN-59-842) (Sponsored jointly by Air Force Office of Scientific Research under AF 61(052)13, phase D and Swedish Atomic Committee) AD 225322; PB 145676

Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 103-104, July 15, 1959.

The observation of a definite case of Λ hyperon emission from an antiproton annihilation in a heavy nucleus in nuclear emulsion is reported. The emulsion stack was exposed to a beam of 740 mev/c antiprotons at the Bevatron. The Λ hyperon is emitted bound in a Λ^4 hyperfragment. From observational data we calculate a Λ binding energy of $2.6 \pm 1.0 \text{ mev}$. (Contractor's abstract)

2144

Uppsala U. Inst. of Physics (Sweden).

THE DECAY OF Au^{194} , by G. Bäckström, O. Bergman and others. [1959] [41]p. incl. diagrs. tables, refs. (AFOSR-524) (AF 61(052)13) AD 254466

Unclassified

Also published in Nuclear Phys., v. 15: 566-602, Mar. 1950.

The decay of Au^{194} was investigated by the use of high resolution spectrometers for the measurements of the conversion spectrum and a double lens spectrometer for coincidence measurements. By careful analysis of the conversion spectrum, which was recorded at a

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resolution of $\approx 0.2\%$, it was possible to identify more than 100 transitions in Pt^{194} . The use of strong sources and a double counter operated in coincidence made possible the detection of lines of intensity only 10^{-5} times that of the strongest line. Multipolarities could be found from K/L ratios for a few low energy transitions and some information could also be extracted from a comparison with results of previous gamma ray work. Energies of the strongest lines were measured absolutely by means of an iron free double focusing instrument, and further energy determinations were made relatively to these lines. A complete set of energy sums was computed in order to survey the possibilities of cascade-crossover combinations. The reliability of the numerical relationships was investigated statistically, and it was shown that a reasonably unique level scheme could be constructed on the basis of energies, although the positions of transitions remained to some extent ambiguous. The results of 79 coincidence experiments are reported, and when analyzed these data lead to a level scheme in agreement with the conclusions of the other approach. Furthermore, these experiments helped in deciding the location of the transitions. Evidence for at least two 0^+ states was found. The discovery of a level at 923 keV, probably of 4^+ character, revealed a close analogy with the level scheme of Pt^{192} . The interpretation of this level as a 3-phonon state is in agreement with theory. (Contractor's abstract)

2145

Uppsala U. Inst. of Physics (Sweden).

0^+ STATES OF Sm^{152} AND Gd^{152} , by I. Marklund, O. Nathan, and O. B. Nielsen. [1959] 15p. incl. diagrs. tables, refs. (In cooperation with Copenhagen U. Inst. of Theoretical Physics) (AFOSR-651) (AF 61(052)13) AD 258323 Unclassified

Also published in Nuclear Phys., v. 15: 199-215, Feb. 1960.

The decay of Eu^{152m} (9.2h) is studied by means of internal and external conversion and $e^- - \gamma$ coincidence measurements with particular interest focused on the possible low-lying 0^+ levels in the transition region between spherical and non-spherical nuclei. Such levels are now found at 615.3 keV in the near-spherical nucleus Gd^{152} and at 685.0 keV in the strongly deformed nucleus Sm^{152} . The experimental K- conversion coefficients for the $0^+ - 0^+$ transitions are > 0.770 and > 0.250 , respectively. The e^-/γ branching ratios μ from the 0^+ levels to the ground states and to the 1st excited 2^+ states are compared with the theoretical values: Gd^{152} : $\mu_{\text{exp}} = 0.010 \pm 0.03$, $\mu_{\text{theory}} = 0.085$; Sm^{152} : $\mu_{\text{exp}} = 0.013 \pm 0.001$, $\mu_{\text{theory}} = 0.13$. (Contractor's abstract)

2146

Uppsala U. Inst. of Physics (Sweden).

NUCLEAR MAGNETIC DIPOLE AND ELECTRIC QUADRUPOLE MOMENTS OF RADIOACTIVE BISMUTH ISOTOPES, by I. Lindgren and C. M. Johansson. [1959] [18]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force [Office of Scientific Research under AF 61-(052)13] and Swedish Atomic Committee)

Unclassified

Published in Arkiv Fysik, v. 15: 445-462, 1959.

The hyperfine structure of the neutron-deficient bismuth isotopes $\text{Bi}^{203-206}$ were studied by the atomic beam magnetic resonance method by use of 6 pole focusing and radioactive detection. The magnetic dipole moments (μ_1) are calculated from the magnetic dipole interaction constants (a) by means of the known values of (Mc/s) and μ_1 of Bi^{209} and the Fermi-Segré formula, neglecting the hfs anomaly. In order to obtain the electrical quadrupole moments (Q) from the electric quadrupole interaction constants (b), the intermediate state of bismuth was determined from the optically measured energy levels and from the known g_J -value of the ground state. The average of the inverse cube of the distance of the electrons from the nucleus, $\langle r^{-3} \rangle$, was calculated from the magnetic dipole interaction in Bi^{209} and is compared with the value obtained from the spin-orbit coupling. The quadrupole moments are not corrected for the effect of distortion of the inner electron shells (Sternheimer's correction). The results are compared with theoretical values obtained from the nuclear shell model. (Contractor's abstract)

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Utah U. Dept. of Chemical Engineering, Salt Lake City.

IGNITION OF COMPOSITE PROPELLANTS, by A. D. Baer, N. W. Ryan, and D. L. Salt. Mar. 1959, 74p. incl. illus. diagrs. tables, refs. (AFOSR-TN-59-516) (AF 49(638)170) AD 216291 Unclassified

An investigation is made of the conditions under which aerodynamic shock will ignite composite solid rocket propellants. Four different propellants, 3 containing ammonium perchlorate and 1 containing ammonium nitrate were exposed in a shock tube to conditions behind reflected shock waves. The 3 perchlorate propellants ignited under much milder conditions when restrictor failure permitted the shock to travel down narrow channels bounded by propellant surface. All evidence gathered points to the conclusion that binder reacts with environmental oxygen, probably after some binder decomposition, the binder-oxygen reaction supplying energy to promote the later oxidant-binder reaction. It is shown that under radiation ignition,

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relatively slow and carried out under atmospheric pressure, the perchlorate propellants are very similar, but under high flux ignition the perchlorate propellants are very different indeed. It is concluded that if environmental oxygen is present at a high enough partial pressure, it will burn with binder decomposition products before oxygen is available from the oxidant.

2148

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

CRATERING EXPERIMENT AND THEORY, by E. P. Palmer, R. W. Grow and others. [1959] [19]p. incl. illus. diagrs. tables. (AFOSR-TN-59-1201) (Sponsored jointly by Air Force Office of Scientific Research under [AF 49(638)462] and Air Force Ballistic Missile Division) Unclassified

Published in Proc. Fourth Symposium on Hypervelocity Impact, Eglin Air Force Base, Fla., (Apr. 26-28, 1960), Eglin Air Proving Ground Center, Sept. 1960, paper no. 13. (APGC-TR-60-39 (I)).

In order to determine the importance of various target and projectile characteristics in cratering produced by high-velocity impact, experiments were carried out in which target and projectile materials were systematically varied. In 1 series of experiments, steel spheres were impacted upon targets of copper, lead, aluminum, magnesium, zinc, silver, and steel. In another series, projectiles of nylon, K-monel metal, pyrex glass, stainless steel types 302 and 440, naval brass, copper, aluminum, diamond, magnesium, tungsten, high-carbon chrome steel, and lead were impacted upon lead targets. Velocities up to 2.5 km/sec were used. Crater volume was found to be directly proportional to projectile energy for all targets and projectiles. Results

could be correlated by the formula $\frac{V}{E} = k \frac{\rho_p}{P_t}^{\frac{1}{2}}$ where

where V = crater volume, E = projectile energy, ρ_p = projectile density, P_t = target shear strength, and $k = 7.3 \times 10^{-4}$ (using MKS units). A comparison is made with other theories which attempt to correlate impact phenomena by means of velocity of sound, heat of fusion, and projectile and target densities. The possibilities of checking the hydrodynamic theory of R. L. Bjork are discussed. (Contractor's abstract)

2149

Utah U. [Dept. of Electrical Engineering] Salt Lake City.

EXPERIMENTAL INVESTIGATION OF SPRAY PARTICLES PRODUCING THE IMPACT FLASH, by R. W. Gray, R. R. Kadesch and others. [1959] [14]p. incl. illus. diagrs. tables. (AFOSR-TN-59-1202) (AF 49(638)462) Unclassified

Published in Proc. Fourth Symposium on Hypervelocity Impact, Eglin Air Force Base, Fla., (Apr. 26-28, 1960), Eglin Air Proving Ground Center, Sept. 1960, paper no. 37. (APGC-TR-60-30 (III))

Spectrograph observations were made for copper projectiles impacting into copper targets in various controlled atmospheres. An atomic copper line with a 7.1 ev excitation energy was excited in an argon atmosphere so that an energy of at least this magnitude was available for the excitation of copper atoms. These results indicate that in argon, the light was produced by micron-size copper particles ejected from the target with velocities no less than 7 km/sec. A collision process between copper atoms evaporated from the heated spray particles and atoms of the argon atmosphere can account for the observed copper lines. In a medium of hydrogen, the impact flash was dimmer by at least 2 orders of magnitude with no detectable line structure. The relative velocity between copper atoms and hydrogen molecules required to produce copper lines is greater than 18 km/sec in a collision process. Experimental measurements indicate that at least 3 mechanisms contribute to the observed impact flash. These may be listed as follows: (1) atomic electron transitions, (2) thermal or black-body radiation, and (3) burning or chemical reaction. In order to verify the existence of the fine high velocity spray particles, photo tubes were set up along the path of the particles to measure their arrival time at various points along the path. The initial velocity of the spray particles was calculated from the photo tube measurements. Spray particles with initial velocities as high as 15 km/sec were observed in the impact spray from copper to copper impacts confirming the results obtained with the spectrographic observations. (Contractor's abstract)

2150

Utah U. [Dept. of Metallurgy] Salt Lake City.

MECHANISM OF CRATERING IN ULTRA-HIGH VELOCITY IMPACT, by M. A. Cook. Jan. 30, 1959 [26]p. incl. illus. diagr. tables, refs. (AFOSR-TN-59-50) (AF 18(603)100) AD 209413; PB 142679

Unclassified

Also published in Jour. Appl. Phys., v. 30: 725-735, May 1959.

The equations of the hydrodynamic theory of penetration of targets by shaped charge jets are presented first in general form. These equations are expressed in the ideal form and examined by experimental observations. Then a non-ideal theory is presented that takes into account heat losses by compression, shock heating, and radiated shock waves. The conditions for impact explosions of targets are discussed and a theory extended to cover the entire velocity range of impact from the plastic deformation threshold v_{π} to well above the

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impact explosion threshold v_c . Some experimental evidence relating to this more general theory is also presented. (Contractor's abstract)

2151

Utah U. [Dept. of Metallurgy] Salt Lake City.

ELECTRICAL FIELDS AND ELECTROMAGNETIC RADIATION FROM CHEMICAL EXPLOSIONS, by R. T. Keyes. Mar. 19, 1959 [54]p. incl. diagrs. table. (AFOSR-TN-59-551) (AF 18(603)100) AD 216691
Unclassified

Electrical fields and electromagnetic radiation generated by chemical detonations of charges ranging in size from 10 g to roughly 25 kg were investigated over a frequency range extending from a few cps to 500 mcps. The electrical energy in all cases was found to cover a broad band of frequencies with the largest potentials occurring in a frequency range below a few hundred cps. Little of the low frequency signals were radiated. Megacycle range signals (predominately radiation) were found to occur in the form of short random bursts. A nonreproducible delay the order of several hundred μ sec was found to exist between the time of detonation and the appearance of the first bursts of radiation. The electrical potentials of the expanding explosion products were estimated, and for a 552 g 50/50 pentolite charge the maximum value was determined to be 18,000 v. For bare charges this quantity was considered to vary roughly in direct proportion to the charge weight. Experiments are described which were performed to ascertain the mechanism whereby the electrical fields and EM radiation are generated by chemical detonations, and a model is proposed.

2152

Utah U. [Dept. of Metallurgy] Salt Lake City.

RECOMBINATION SHOCK IN DETONATION-GENERATED PLASMAS, by M. A. Cook and R. T. Keyes. [1959] [5]p. incl. illus. (AFOSR-TN-59-1285) (AF 18(603)100) AD 216691
Unclassified

Properties of detonation-generated (d-g) plasmas are discussed, and the results previously analyzed are recapitulated. It is pointed out that the d-g plasmas have high cohesion attributed to a quasi-lattice, metallic-like structure in which the cohesive energy ϵ_c is comparable in magnitude to the ionization potential I for the product gases in a vacuum. The external d-g plasmas have a lower density and thus lower ϵ_c , yet remain metastable as long as ϵ_c is appreciably greater than kT . At low ϵ_c they decay by thermal agitation, or they explode at higher ϵ_c if their structure is suddenly upset. A μ sec/frame sequence of an external d-g plasma with

the associated shock pattern shows that the jet propulsion in the d-g plasma is the cause of its quick separation from the main detonation products and its propagation at superdetonation speed.

2153

Utah U. [Inst. for the Study of Rate Processes] Salt Lake City.

KINETICS OF THE STEAM-CARBON REACTION, by G. Blyholder and H. Eyring. [1959] [4]p. incl. diagrs. (AF 33(038)20839) AD 216691
Unclassified

Published in Jour. Phys. Chem., v. 63: 693-696, May 1959.

The data for the steam-graphite reaction from 900 to 1300° and in the 5 to 100 μ pressure range are presented as a function of both pressure and temperature. The rate-determining processes are the adsorption of water vapor and the desorption of molecular hydrogen from the surface. Absolute rate theory calculations lead to the conclusion that the adsorbed species have a limited mobility upon the surface. (Contractor's abstract)

2154

Utah U. [Inst. for the Study of Rate Processes] Salt Lake City.

KINETICS OF GRAPHITE OXIDATION. II, by G. Blyholder and H. Eyring. [1959] [5]p. incl. diagrs. tables. (AF 33(038)20839) AD 216691
Unclassified

Published in Jour. Phys. Chem., v. 63: 1004-1008, June 1959.

The kinetics of the oxygen-graphite reaction in the 800 to 1300° temperature range and 1 to 100 μ pressure range are investigated. Above 1000° the true surface reaction is half order with respect to oxygen and the activation energy is small. The effect of the diffusion of oxygen into the pores of the graphite sample is elucidated. Absolute rate theory together with the observed kinetics is used to develop a mechanism for the reaction. (Contractor's abstract)

2155

Utah U. [Inst. for the Study of Rate Processes] Salt Lake City.

A SENSITIVITY TEST FOR KINETIC DATA, by J. R. Morrey and C. R. Hill. Mar. 31, 1958, 12p. incl. diagrs. tables. (Technical rept. no. 2) (AFOSR-TN-59-1) (AF 49(638)28) AD 208181
Unclassified

A simple test for the sensitivity of kinetic data is presented. Some conclusions that are derived are as follows: (a) unless the dimensionless quantity $\phi_n(t)$ is

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greater than a critical value, the rate data are too insensitive to be of any value in determining a reaction order; (b) if a 1st order plot is made with data whose $|\phi|$ is less than the critical value, then the mechanism may or may not be first order; (c) it is possible to determine whether an order is changing with time or whether the non-variant order has

not been correctly determined by applying the test to any seemingly linear section of an order plot; (d) in the case that planning an experiment form which one can obtain a sensitive rate plot is inconvenient or impossible, order is often obtained by measuring initial rates and determining their dependence on initial concentration.



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Virginia Inst. for Scientific Research, Richmond.

THE EFFECT OF FOREIGN METALS ON THE CORROSION OF TITANIUM IN BOILING 2M HYDROCHLORIC ACID, by W. R. Buck, III, B. Sloope, and H. Leidheiser, Jr. Dec. 22, 1958 [54]p. incl. diagrs. tables. (AFOSR-TR-59-5, pt. 1) (AF 18(600)1319) AD 208758; PB 139592
Unclassified

Abstract also published in Virginia Jour. Sci., v. 10: 265, Sept. 1959.

Also published in Corrosion, v. 15: 26-30, Nov. 1959.

The rate of corrosion of titanium was determined in boiling 2M HCl when contacted to aluminum, cadmium, tin, zirconium, lead, bismuth, mercury, silver, copper, antimony, vanadium, 70:30, 50:50, and 30:70 copper-nickel alloys, iron, palladium, cobalt, nickel, gold, rhodium, platinum, and iridium. Less extensive corrosion measurements of the same type were also made in 0.6 and 2M H₂SO₄. The potentials of the couple and of the two members of the couple were determined in boiling 2M HCl for 20 of the systems studied. A plot of the corrosion rate vs the couple potential yielded a polarization curve which was similar to the anodic polarization curve for titanium with an impressed voltage. The curve exhibited a maximum in corrosion rate at a couple potential of -0.49 volt vs the saturated calomel electrode. The potential of titanium in boiling 2M HCl was also determined as a function of concentration of the following metallic cations in the acid: copper, silver, antimony, nickel, gold, palladium, rhodium, platinum, and iridium. The influence of the cations on the corrosion rate was explained in relation to the polarization curve. (Contractor's abstract)

2157

Virginia U. Dept. of Chemistry, Charlottesville.

HIGH TEMPERATURE ANTIOXIDANTS FOR SYNTHETIC FLUIDS, by J. W. Cole, Jr. Jan. 1959 [11]p. incl. refs. (AFOSR-TN-59-149) (AF 13(603)103) AD 210983
Unclassified

Presented at meeting of the Chem. Marketing and Econ. Div. of the Amer. Chem. Soc., Chicago, Ill., Sept. 7-12, 1958.

Abstract published in 131th meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 4-H.

Studies were made (1) to evaluate antioxidants for possible use at 400°F and above in synthetic fluids, (2) to synthesize likely antioxidants related to phenothiazine (thiodiphenylamine) and other promising types, and (3) to study modes and mechanisms of antioxidant action at elevated temperatures. Over 400 different compounds, representing a broad spectrum of additives,

were examined in selected combinations with about 20 synthetic fluids. The types of fluid included ester fluids, silicates, silicones, silanes, phosphates, and mineral oil. About 50 derivatives of phenothiazine were synthesized and characterized, most of which were evaluated as antioxidants. The ring-substituted derivatives of phenothiazine showed varying degrees of antioxidant activity. The oxidation behavior of blended fluids was examined in the presence of metals such as Cu, Ag, Mg, and alloys of Fe, and Ti. Some metals, like Cu, appeared to help generate antioxidant species, especially with amines. Atoms of N, S, and Se are important elements in antioxidants when located in strategic positions in the molecule.

2158

Virginia U. Dept. of Mathematics, Charlottesville.

ON THE CONSTRUCTION OF PERIODIC MAPS WITHOUT FIXED POINTS, by P. E. Conner and E. E. Floyd. Oct. 1958, 14p. (Technical note no. 9) (AFOSR-TN-59-81) (AF 49(638)72) AD 210141; PB 110238
Unclassified

Also published in Proc. Amer. Math. Soc., v. 10: 354-360, June 1959.

The existence problem for fixed points of periodic maps where the period is not a prime power is considered. Proof is given of the theorem: If r is a positive integer greater than one which is not a prime power, then there exists a compact, finite dimensional space X with trivial integral Čech cohomology groups and a map $T: X \rightarrow X$ of period r which is without fixed points. If r is described as above, then there exists a contractible manifold M and a map $T: M \rightarrow M$ of period r and without fixed points.

2159

Virginia U. Dept. of Mathematics, Charlottesville.

OPEN MAPPINGS ON 2-DIMENSIONAL MANIFOLDS, by G. T. Whyburn. June 1959, 30p. (Technical note no. 10) (AFOSR-TN-59-581) (AF 49(638)72) AD 217028; PB 142732
Unclassified

Also published in Jour. Math. and Mech., v. 10: 181-197, Jan. 1961.

A new localization theorem is presented for light open mappings in a general setting. This can be and is applied to obtain the scattered inverse property in a new way dependent on a reduction-to-boundary method. This localization theorem makes possible the development of results without making use of the scattered inverse theorem. As the development proceeds, the scattered inverse theorem itself emerges as a direct consequence of much stronger conclusions concerning local action of the mapping. (Contractor's abstract)

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Virginia U. Dept. of Mathematics, Charlottesville.

MAPPING NORMS, by G. T. Whyburn. July 1959, 12p. (Technical note no. 13) (AFOSR-TN-59-725) (AF 49-638)72) AD 220353; PB 143506 Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1431-1436, Sept. 1959.

Certain cases are analyzed of the following general question: for a given metric space X and class T of mappings, under what conditions does there exist a positive constant $d(X, T)$ such that any mapping of the class T operating on X as its domain is necessarily of norm $\geq d(X, T)$? Results pertain largely with cases in which the spaces X are simple closed curves and the mappings are non-topological open mappings. Application is made to the case where X is an arbitrary 2-dimensional manifold. Proofs for the main theorems are sketched and are complete only for the cases of circles, although the statements are made in their full generality. (Contractor's abstract, modified)

2161

Virginia U. Dept. of Mathematics, Charlottesville.

TRANSFORMATION GROUPS ON A $K(\pi, 1)$ [I], by P. E. Conner and D. Montgomery. June 1959, 15p. (Technical note no. 11) (AFOSR-TN-59-733) (AF 49(638)72) AD 220354; PB 143161 Unclassified

Also published in Michigan Math. Jour., v. 6: 405-412, 1959.

Some results are given on transformation groups and fiberings for a finite dimensional Eilenberg-MacLane space $K(\pi, 1)$. The eventual developing of extensive relations between homotopy groups and cyclic transformations is desired. If a finite dimensional $K = K(\pi, 1)$ is fibered by a connected fiber F with base B , then F is a $K(\pi_1, (F), 1)$ and B is a $K(\pi_2, (B), 1)$. The result concerns those compact manifolds which are aspherical. If a compact connected Lie group acts effectively on such a manifold, the group is shown to be a toral group. If π is abelian, there is a cross-section in the large. The action might then be called a product action. (ASTIA abstract)

2162

Virginia U. Dept. of Mathematics, Charlottesville.

THE ABSOLUTE CONTINUITY OF TOEPLITZ'S MATRICES, by M. Rosenblum. July 1959, 14p. (Technical note no. 14) (AFOSR-TN-59-725) (AF 49(638)-72) AD 220355, PB 143160 Unclassified

Also published in Pacific Jour. Math., v. 10: 987-996, 1960.

If W is real-valued and semi-bounded, T defines a semi-bounded symmetric operator in L^2 , whose Friedrichs extension is the Toeplitz operator $T(W)$. The following theorems are proved (1) $T(W)$ is absolutely continuous (that is, the associated spectral measure is Lebesgue absolutely continuous). (2) If W is even and $\sum |w_n| < \infty$, then $T(W)$ is unitarily equivalent to the multiplication operator $f \rightarrow Wf$ on a subspace $L^2(A)$ where A is a suitable subset of $(0, \pi)$. In the proof of (1) a dependence on the Aronszajn-Donoghue theory of exponential representations of holomorphic functions is shown while for (2) a theorem of the reviewer on perturbation of continuous spectra is used.

2163

Virginia U. [Dept. of Mathematics] Charlottesville.

LINEAR OPERATOR EQUATIONS, by G. Lumer and M. Rosenblum. [1959] [10]p. (AF 49(638)72) Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 32-41, Feb. 1959.

Similarities are discussed between the present work and papers by Y. L. Daleckiĭ (Uspehi Mat. Nauk, v. 14: 165-168, 1959) and M. Rosenblum (Duke Math. Jour., v. 23: 263-269, 1956). It is pointed out that this paper is more general than that by Daleckiĭ in replacing $P(a, b) = \sum_{j,k=0}^n c_{jk} (a_1)^j (b_1)^k$ by $\sum_{j=1}^n j! a_1^j b_1^j$ for $\{a_j\}$ an arbitrary set of commuting elements of R and likewise for $\{b_j\}$. It is less general, when it considers the special case where the a_j are powers of a single "a" and the b_j of a single "b", in restricting $\Phi(\lambda, \mu)$ to be of the form $\sum_{j=1}^n f_j(\lambda) g_j(\mu)$ with f_j and g_j separately analytic in appropriate domains. With these changes the main results in the two papers are essentially identical. (Math. Rev. abstract)

2164

Virginia U. Dept. of Mathematics, Charlottesville.

TRANSFORMATION GROUPS ON A $K(\pi, 1)$, II, by P. E. Conner. [1959] [5]p. [AF 49(638)72] Unclassified

Published in Michigan Math. Jour., v. 6: 413-417, 1959.

A study is presented on a finite-dimensional $K(\pi, 1)$ by methods introduced in a recent study (item no. 2161). Let $(T, (K, x))$ be an involution on K with a fixed base point x , and let T_* be the automorphism of $\pi_1(K, x) = \pi$ induced by T . Let $C = \{\sigma \mid \sigma \in \pi, T_*(\sigma) = \sigma^{-1}\}$

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and define $\sigma_1 \sim \sigma_2$ for $\sigma_1, \sigma_2 \in C$ if there is a $\sigma \in C$ such that $T_*(\sigma)\sigma_1 = \sigma_2\sigma$. \hat{C} denotes the set of equivalence classes of C . Let $H(\sigma) = \{\sigma_1 | \sigma_1 \in \pi, T_*(\sigma_1) = \sigma\sigma_1\sigma^{-1}\}$. It is proven that the components F_c of the fixed-point set F are in one-to-one correspondence with elements of C ; and for every F_c , there is an element $\sigma \in C$ such that $H^1(F_c; \mathbb{Z}_2) \cong H^1(H(\sigma); \mathbb{Z}_2)$. As examples the results apply to a free abelian group π of rank n , and also apply to a question raised by R. H. Fox, about the type of knot which can be imbedded in S^3 in such a way that it is invariant under some involution of the sphere. (Math. Rev. abstract modified)

2165

Virginia U. [Dept. of Physics] Charlottesville.

FAST NEUTRONS FROM TANTALUM AND GOLD, by L. B. Aull, G. C. Reinhardt, and W. D. Whitehead. [1959] [8]p. incl. diagrs. table, refs. (AFOSR-TN-59-666) (AF 49(638)176) Unclassified

Abstract published in Virginia Jour. Sci., v. 10: 244, Sept. 1958.

Also published in Nuclear Phys., v. 13: 292-299, Oct. 1959.

The photonuclear cross sections for the production of neutrons with energies greater than the $Si^{28}(n,p)Al^{28}$ threshold have been determined for tantalum and gold from a maximum bremsstrahlung energy of 18 to 65 mev. The integrated cross section to 65 mev is about 800 mev · mb for tantalum and 700 mev · mb for gold. The fast neutron integrated cross section is compared with total neutron production cross section at several energies and is about 10% at all energies. (Contractor's abstract)

2166

Virginia U. [Dept. of Physics] Charlottesville.

PHOTONEUTRON CROSS SECTIONS OF Li, N, AND A, by R. W. Fast, P. A. Fluornoy and others. [1960] [5]p. incl. illus. diagrs. table, refs. (AFOSR-TN-59-1172) [AF 49(638)176] Unclassified

Published in Phys. Rev., v. 118: 535-539, Apr. 15, 1960.

Using a Halpern-type photoneutron detection system, the photoneutron yields from Li, N^{14} , and A^{40} have been measured as a function of the maximum bremsstrahlung energy from threshold to approximately 50 mev. The method of Penfold and Leiss was used to extract from the yield curves the total neutron cross

section; $\sigma_T = \sigma(\gamma, n) + \sigma(\gamma, pn) + 2\sigma(\gamma, 2n) + \dots$. The results are compared with previous findings of other laboratories. No gross structure was detected in the lithium cross section in the giant resonance region. The data indicate that lithium has a high-energy tail on the cross section of considerable magnitude.

2167

Virginia U. [Dept. of Physics] Charlottesville.

PHOTONEUTRONS FROM LITHIUM AND NITROGEN (Abstract), by P. A. Fluornoy, R. S. Tickle and others. [1959] [1]p. [AF 49(638)176] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 257, Apr. 30, 1959.

The cross section for photoneutron production has been determined for lithium and nitrogen as a function of x-ray energy from 11 to 55 mev using the bremsstrahlung from the Virginia U. synchrotron. The neutrons were detected in a Halpern type counter consisting of six BF3 counters in a moderator which was gated to count between beam pulses. The beam intensity was monitored with a NBS-type thick-walled transmission ion chamber. One 1 1/4-in.-diam stainless steel tube filled with gas to 2100 lb/cm² was used as a target for the nitrogen; the lithium target was natural metallic lithium encased in a thin plastic cylinder. The data were taken at 1-mev intervals in the bombarding energy, and the cross sections were extracted from the yield curve using the Leiss-Penfold matrices. The integrated cross sections determined were Li σ int (11-60 mev) 0.090 mev barn; N_2 σ int (13-55 mev) 0.165 mev barn.

2168

Virginia U. [Dept. of Physics] Charlottesville.

YIELD OF FAST PHOTONEUTRONS FROM TANTALUM AND GOLD (Abstract), by L. B. Aull, G. C. Reinhardt, and W. D. Whitehead. [1959] [1]p. [AF 49(638)176] Unclassified

Presented at meeting of the Amer. Phys. Soc., Washington, D. C., Apr. 30-May 2, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 257, Apr. 30, 1959.

The yield of neutrons from tantalum and gold with energies above the $Si^{28}(n,p)Al^{28}$ threshold has been determined as a function of the maximum bremsstrahlung energy from 18 to 64 mev at 1-mev intervals using the Virginia U. synchrotron. Silicon powders

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packed between two thin-walled concentric plastic cylinders was used as a neutron detector. One-in.-diam cylindrical samples of the metals were mounted axially with the beam and the 2-in.-diam detector was mounted coaxially with the sample. The residual

Al^{28} activity was measured with a manifold of 3 Geiger counters. The beam intensity was monitored with the Cu^{62} activity from the $\text{Cu}^{63}(\gamma, n)\text{Cu}^{62}$ reaction in thin copper disks. The normalized functions for the gold and tantalum are identical within the counting statistics of about 5% and both increase at higher energies, but this might be due to the assumptions concerning the fast neutron spectrum. The integrated cross section to 64 mev is 0.750 mev barns and at 30 mev is about 5% of the total neutron integrated cross section.

2169

Virginia U. [Dept. of Physics] Charlottesville.

PHOTO-PROTON YIELDS FROM LIGHT ELEMENTS (Abstract), by D. C. Worth and G. R. Haste. [1959] [1]p. [AF 49(638)176] Unclassified

Presented at Thirty-seventh annual meeting of the Virginia Acad. Sci., Charlottesville, May 6-9, 1959.

Published in Virginia Jour. Sci., v. 10: 244-245, Sept. 1959.

Using high energy x-rays from the University of Virginia synchrotron, various investigators are studying "photonuclear" reactions (in which x-ray energy absorbed by a target nucleus results in emission of one or more nucleons). Photoneutrons are generally more abundant than photoprotons from medium and heavy elements, but investigation of how either type of emission varies with x-ray energy can give important information about nuclear processes involved in photo-absorption and emission. This paper outlines experiments

for the direct counting of photoprotons from several light elements (especially carbon and lithium) by means of thin scintillation crystals, and presents some preliminary results.

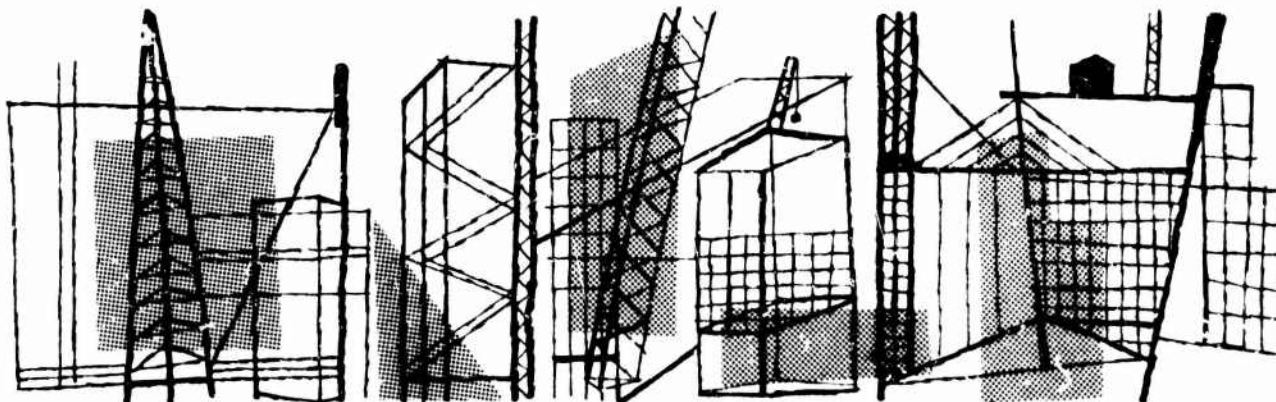
2170

[Vitro Corp. of America] Vitro Labs., West Orange, N. J.

THE PHYSICAL PROPERTIES OF HIGH INTENSITY ARC PLASMA (Abstract), by L. Mead, J. Cooney, and C. Sheer. [1959] [1]p. (Bound with its AFOSR-TN-59-770; AD 241053) [AF 49(638)323] Unclassified

Presented at Second AFOSR Contractors meeting on Ion and Plasma Propulsion, North American Aviation, Inc., Rocketdyne Div., Canoga Park, Calif., July 8-9, 1959.

This study was undertaken with a view toward developing methods of accelerating the vapor plasma from a high intensity arc for propulsion applications. The various flame parameters have been investigated (heat flux, mass flow rate, and velocity, as well as some rough measurements of temperature), particularly at low ambient pressures. In addition, methods are currently under investigation to achieve higher plasma source temperatures with the high intensity arc by attempting to achieve stable operation at considerable higher anode current densities. This is being attacked as an analogue of the confinement problem which includes the electrode-discharge boundaries as well as the conduction column. The method under study involves the use of strong magnetic fields at very low operating pressures; wherein the ratio of magnetic to gas pressure might be $\sim 10^4$. Another phase in this program is concerned with the acceleration of the high flux plasma from the high intensity arc from its natural velocity ($\sim 10^2$ ft/sec.) up to velocities useful for a plasma propulsion device ($> 10^4$ ft/sec.). Two techniques for accomplishing acceleration of the free plasma flame are discussed.



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Washington U. [Dept. of Mathematics] St. Louis, Mo.

ON THE EXTENSIONS OF POSITIVE DEFINITE FUNCTIONS, by A. Devinatz. [1959] [26]p. incl. refs. (AF 18(600)568) Unclassified

Published in Acta Mathematica, v. 102: 109-134, 1959.

Let G be an Abelian locally compact group, Q a symmetric neighborhood of the identity, and f a continuous function defined on $2Q$ and positive definite on Q : for

any set $(*)$ -- $\sum_{j=1}^n \sum_{k=1}^n \zeta_j \bar{\zeta}_k f(x_j - x_k) \geq 0$. It is possible to extend $f(x)$ to all of G so as to retain property $(*)$? The present paper shows that it is negative for the circle group, and affirmative for the discrete group of integers. The problem is open, however, for Euclidean space of any dimension. By placing additional restrictions, it can be affirmative for the (x_1, x_2) -plane stated as follows: Let Q be the rectangle $|x_1| < a_1$, $1 = 1, 2$: if (i) $f(x_1, 0)$ and (ii) $f(0, x_2)$ each have unique positive definite extensions along the x_1 -axis and x_2 -axis respectively, then there is a unique non-negative measure dF such that $f(x_1, x_2) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \exp i(x_1 t_1 + x_2 t_2) dF(t_1, t_2)$. A similar result holds for the discrete Euclidean space. This is an exact analogue of an earlier theorem on the 2-parameter moment problem (see WAS.02:022, Vol. I). The author proves also that (i) may be replaced by (ii): there is an $\epsilon > 0$ such that the restriction of $f(x_1, 0)$ to $(-2a_1 + \epsilon, 2a_1 - \epsilon)$ has a unique extension. The proofs are based on: Set $g(x) = \sum \zeta_k f(x - x_k)$, $h(x) = \sum \eta_j f(x - y_j)$, $(g, h) = \sum_1^n \sum_1^m \zeta_j \bar{\eta}_i f(y_j - x_k)$. Thus, a Hilbert space F of functions $g(x)$ defined on Q is obtained. Let D_1 be the linear manifold in F such that $\partial g(x)/\partial x_1$ exists and belongs to F , and define the operator $A_1 g(x) = i \partial g(x)/\partial x_1$ on D_1 . It is proven that the operator A_1^* exists and has self-adjoint extension H_1 , and if dE_1 is the canonical spectral measure of H_1 , $u = (1, 0)$ and $U(x_1 u) = \int_{-\infty}^{\infty} \exp(ix_1 t) dE_1(t)$, $-\infty < x_1 < \infty$, then $U(x_1 u)g(x) = g(x + x_1 u)$ for any $g \in F$, $x + x_1 u \in Q$. Similarly are defined A_2 and $U(x_2 v)$, $v = (0, 1)$. If (1) $U(x_1 u)U(x_2 v) = U(x_2 v)U(x_1 u)$, then $F(x) = (U(x_1 u)U(x_2 v)g_0, g_0)$, $g_0(x) = f(x - 0)$, provides the desired extension of f to the whole plane. The main difficulty in the problem posed above is the proof of relation (1). The restrictions (i) or (ii) put on f allow this relation to be proved by a careful examination of the domains of the operators.

2172

Washington U. Dept. of Physics, St. Louis, Mo.

[PARAMAGNETIC RESONANCE OF FREE RADICALS] by R. E. Norberg. Interim final rept. Oct. 1, 1958, 3p. (AFOSR-TR-59-40) (AF 18(600)1133) AD 214509 Unclassified

A summary is given on the determination of electronic structure of free radicals by paramagnetic resonance and studies of dynamical processes such as charge exchange and spin exchange. Appended to this report are 10 reprints describing the work accomplished (see WAS.04:002-008; WAS.04:011-014, Vol. 1, for abstracts)

2173

Washington U. Dept. of Physics, St. Louis, Mo.

MOLECULAR IONS, by R. N. Varney. [1959] [3]p. incl. diagrams (AF 18(600)1317) Unclassified

Published in Jour. Chem. Phys., v. 31: 1314-1316, Nov. 1959.

Physico-chemical analysis of data concerning drift velocities of ions in nitrogen discloses that N_4^+ ions are the stable ones at low temperature and E/p_0 and that the ions dissociate into N_2^+ and N_2 at higher E/p_0 , higher temperature, or lower pressure. The dissociation behaves identically with thermal dissociation of molecular gases. The analysis yields the following numerical data: N_4^+ binding energy against dissociation into N_2^+ and N_2 , 0.50 eV; Ion temperature in $^\circ K$ as a function of E/p_0 in v/cm/mm Hg, $\theta = 12.5 E/p_0$. (Contractor's abstract)

2174

Washington U. [Dept. of Physics] St. Louis, Mo.

MUON CAPTURE IN CERTAIN LIGHT NUCLEI, by A. Fujii and H. Primakoff. Mar. 1959 [29]p. incl. refs. (Technical rept. no. 20) (AFOSR-TN-59-28) (In cooperation with Purdue U., Lafayette, Ind.) (AF 18(600)1579) (AF 18(603)108) AD 208873 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 4: 39, Jan. 28, 1959.

Also published in Nuovo Cimento, Series X, v. 12: 327-355, May 1, 1959.

The partial transition rate of the muon-capture reactions $^3He - H^3$, $Li^6 - He^6$, and $C^{12} - B^{12}$ in which the daughter

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nucleus is found in its ground state is calculated by making use of the comparison with the beta-decay transition rate of the daughter nucleus from the ground state back to the ground state of the parent nucleus. Also the universality in coupling constants and coupling schemes, V-A, between beta decay and muon capture is assumed. The "induced" pseudoscalar interaction and the correction due to "divergenceless" current are both included in the basic Hamiltonian. The nuclear matrix element is evaluated using a variational trial wave function for He^3 and an oscillator potential wave function in LS and jj coupling shell theory for Li^6 and C^{12} , respectively. The calculated partial capture rate is in agreement with experiment which exists only for C^{12} at present. (Same as item no. 1805)

2175

Washington U. Dept. of Physics, St. Louis, Mo.

A SPHERICAL WAVE EXPANSION FOR DOUBLE β -DECAY, by S. P. Rosen. Jan. 1959 [6]p. (Technical rept. no. 18) (AFOSR-TN-59-91) (AF 18(603)108) AD 229980 Unclassified

Also published in Canad. Jour. Phys., v. 37: 780-785, 1959.

Spherical wave solutions of the Dirac equation for a central field and the properties of angular momentum coupling coefficients are used in a general formulation of the theory of neutrino-less double β -decay transitions of arbitrary forbiddenness.

2176

Washington U. Dept. of Physics, St. Louis, Mo.

FREE INDUCTION DECAYS OF ROTATING SOLIDS, by I. J. Lowe. [1959] [3]p. incl. diagrs. (Technical rept. no. 14) (AFOSR-TN-59-160) (AF 18(603)108) AD 211119 Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 285-287, Apr. 1, 1959.

A theoretical argument predicts that the effect of spinning a nuclear resonance sample at a frequency f_g should be to produce periodic signals at a frequency f_g in addition to the normal free induction decay. The corresponding line space should be narrower in the central region but should possess sidebands at frequencies of multiples of $2f_g$. Experiments on the F^{19} resonance in CaF_2 and Teflon confirm this.

2177

Washington U. Dept. of Physics, St. Louis, Mo.

ON THE ELECTRON COINCIDENCE SPECTRUM IN DOUBLE BETA DECAY, by S. P. Rosen. [1959] [13]p. incl. diagrs. table, refs. (Technical rept. no. 33) (AFOSR-TN-59-161) (AF 18(603)108) AD 247257 Unclassified

Also published in Proc. Phys. Soc. (London), v. 74: 350-362, 1959.

Though simple qualitative arguments imply that the electron coincidence spectra for 2-neutrino, and for 0-neutrino double β -decay are broadly peaked at $\frac{1}{2}E_0$ and infinitely sharply peaked at E_0 , respectively (E_0 is the energy release), a recent calculation has shown that in some circumstances the 2-neutrino case spectrum may also be broadly peaked in the region of E_0 . A simple model, in which only 1 state of the intermediate nucleus gives a non-zero contribution to the matrix element, is used to recalculate these spectra. Two extreme approximations are considered: the energy of the intermediate state is equal to, or much greater than, that of the initial state. In both cases, the qualitative result is confirmed, and the recent calculation mentioned above is regarded as incorrect. The model is applied to the double β -decays of Zr^{96} and Ca^{48} . The relation between the conservation of lepton "charge" and the shape of the spectrum is also considered in some detail. (Contractor's abstract)

2178

Washington U. Dept. of Physics, St. Louis, Mo.

THEORY OF SOLID He^3 , by N. Bernardes and H. Primakoff. [1959] [13]p. incl. diagrs. tables, refs. (Technical rept. no. 15; technical rept. no. 36) (AFOSR-TN-59-238) (AF 18(603)108) AD 212101; AD 257507 Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 290-292, Apr. 1, 1959. (Preliminary rept.)

Also published in Phys. Rev., v. 119: 968-980, Aug. 1, 1960.

A theoretical analysis is given of the properties of solid He^3 on the basis of: (1) a gas-phase Lennard-Jones "12-6" potential modified at small interatomic distances; (2) a Heitler-London type variational-trial wave function for all the atoms in the solid constructed from a properly antisymmetrized product of individual atom orbitals localized on the various lattice points; (3) a Dirac vector model to describe the symmetry energy with an exchange integral deduced from (1) and (2); (4) a spin-wave approximation at "low" temperatures and a Kramers-Opechowski approximation at "high" temperatures for calculation of the free energy of the nuclear spins; and

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(5) a Debye phonon model for the description of the vibrationally excited states of the solid. On this basis, calculated values at low pressures and temperatures ($p \approx 30$ atm; $T \lesssim 1$ °K) are presented for: (a) the cohesive energy per atom; (b) the root mean square deviation of an atom from its lattice site: $\approx 0.36 \times$ nearest neighbor distance; (c) the nuclear magnetic susceptibility which corresponds to an antiferromagnetic behavior with a "paramagnetic" Curie temperature $T_C \approx 0.1$ °K; (d) the variation (decrease) of T_C with increasing pressure corresponding to a possible nuclear antiferromagnetic to nuclear ferromagnetic transition for $p \approx 150$ atm; (e) the specific heat which exhibits an anomaly at $T \approx 0.1$ °K associated with the alignment of the nuclear spins; (f) the thermal expansion coefficient which becomes negative below about 0.6 °K; (g) the melting curve which is characterized by a minimum at $T \approx 0.37$ °K and a maximum at $T \approx 0.08$ °K. Comparison of the theory is made with available experimental data. (Contractor's abstract)

2179

Washington U. Dept. of Physics, St. Louis, Mo.

AN ITERATION OF THE SCATTERING MATRIX IN FINITE TERMS, by K. Haller. [1959] 10p. incl. refs. (AFOSR-TN-59-521) (AF 18(603)108) AD 261901
Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 27-30, 1960.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 5: 81, Jan. 27, 1960.

Computation of collision cross section in quantum field theory are performed by evaluating the T-matrix. The T-matrix is defined when the Hamiltonian can be separated into a free particle interaction. However, the T-matrix not being consistent with requirements for solution to free particle interaction is replaced by the R-matrix. The R-matrix was developed for the Hamiltonian on a free particle interaction. Results indicate that field theories can be classified into 2 varieties: one kind which gives rise to finite weak coupling iterative expansions and another kind which gives rise to infinities. Presumably these latter infinities are indicative of some more deep seated pathology in the field equations or in the approximation by which a non-relativistic Hamiltonian is obtained from a relativistic one. The gradient coupling theory, for example, gives rise to infinite R-matrix elements, though these don't diverge as badly as the corresponding unrenormalized T-matrix elements evaluated by cut-off methods. (ASTIA abstract)

2180

Washington U. [Dept. of Physics] St. Louis, Mo.

MESONIC "EXCHANGE" EFFECTS IN BETA-DECAY, by R. J. Blin-Stoyle, V. Gupta, and H. Primakoff. [1959] [10]p. incl. diagr. table, refs. (Technical rept. no. 21) (AFOSR-TN-59-522) (AF 18(603)108) AD 229973
Unclassified

Also published in Nuclear Phys., v. 11: 444-453, May 1959.

An estimate is made, using no-recoil meson theory, of the π -mesonic exchange contributions to the beta-decay of nuclei assuming that such effects only contribute to the axial vector part of the beta-decay interaction. A few % enhancement in the matrix element for the $H^3 \rightarrow He^3$ decay is obtained which is sufficient to account for the discrepancy between the decays of H^3 and n. A similar effect is found for heavier nuclei. (Contractor's abstract)

2181

Washington U. [Dept. of Physics] St. Louis, Mo.

THE CATALYTIC AND PHOTO DECAY MODES OF THE MUON, by S. P. Rosen. [1959] [11]p. incl. diagrs. table, refs. (Technical rept. no. 32) (AFOSR-TN-59-617) (AF 18(603)108) AD 247257
Unclassified

Also published in Nuovo Cimento, Series X, v. 15: 7-17, Jan. 1, 1960.

It is shown that, on the basis of the usual baryon-lepton direct coupling theory, the catalytic ($\mu + \pi \rightarrow e + \pi$) and the photo ($\mu \rightarrow e + \gamma$) decays of the muon are expected to occur as 2nd order processes in the effective weak interaction Hamiltonian, $\mathcal{H}_{\text{weak}}$. If however, the effective weak interaction itself arises as a consequence of the coupling of baryons and leptons to an intermediate heavy boson ($\langle X \rangle$), these decays are essentially 1st order in $\mathcal{H}_{\text{weak}}$ and are predicted to go so fast as to apparently contradict experimental data, at least in the case of photo decay. Estimates of the rates of the catalytic and photo decays are given both on the direct coupling and on the $\langle X \rangle$ theories, and a comparison with the available empirical limits on these rates is made. (Contractor's abstract)

2182

Washington U. [Dept. of Physics] St. Louis.

POLARIZATION OF PROTONS IN $C^{12(d,p)C^{13}}$, by R. G. Allas and F. B. Shull. [1959] [3]p. incl. diagrs. tables, refs. (Technical rept. no. 30) (AFOSR-TN-59-678) (AF 18(603)108) AD 247257
Unclassified

Also published in Phys. Rev., v. 116: 996-998, Nov. 15, 1959.

The polarization of protons from the ground-state $C^{12}(d,p)C^{13}$ reaction has been measured over an angular range $\theta_1 = 15^\circ$ to $\theta_1 = 60^\circ$ at a deuteron bombarding energy of 10 mev. The polarization was found to be positive at all angles studied, the axis of quantization being defined by $n = k_p \times k_d$. The observed polarizations were 18% at 15° (lab); 11% at 18° ; 13.8% at 24° ; 15.2% at 30° ; 19.5% at 36° ; 44.4% at 48° ; 30% at 54° ; 45.8% at 60° . The results are compared with existing polarization measurements on $C^{12}(d,p)C^{13}$. (Contractor's abstract)

2183

Washington U. Dept. of Physics, St. Louis, Mo.

NUCLEON-STRUCTURAL CORRECTIONS TO FIRST FORBIDDEN UNIQUE BETA TRANSITIONS, by J. F. Drettlein. [1959] [6]p. incl. table, refs. (Technical rept. no. 31) (AFOSR-TN-59-695) (AF 18(603)108) AD 247257 Unclassified

Published in Phys. Rev., v. 116: 1604-1609, Dec. 15, 1959.

The coupling of leptons to a conserved isovector current is shown to result in a small change in the shape of the electron momentum spectrum in forbidden unique beta transitions. The experimental advantages and disadvantages of studying such nucleon-structural effects in forbidden unique transitions rather than in allowed transitions, as suggested by Gell-Mann, are discussed. To facilitate the computations, the beta-decay interaction Hamiltonian is written in a form in which the terms leading to the "nucleon-structural" corrections associated with the coupling of the leptons to a conserved isovector current and the terms leading to effects of comparable order of magnitude are simply identified. (Contractor's abstract)

2184

Washington U. Dept. of Physics, St. Louis, Mo.

THEORY OF MUON CAPTURE, by H. Primakoff. [1959] [21]p. incl. tables, refs. (Technical rept. no. 22) (AFOSR-TN-59-1062) (AF 18(603)108) AD 229973 Unclassified

Also published in Rev. Modern Phys., v. 31: 802-822 July 1959.

The present paper deals with various aspects of the theory of muon capture with emphasis on the relation between theory and experiment. The theory is based on an effective Hamiltonian, $H_{eff}(\mu)$, which describes muon

capture with subsequent neutrino emission by an aggregate of A dressed nucleons:

$$\mu^- + \left\{ \begin{array}{l} Z \text{ protons} \\ A-Z \text{ neutrons} \end{array} \right\} \rightarrow \nu + \left\{ \begin{array}{l} Z-1 \text{ protons} \\ A-Z+1 \text{ neutrons} \end{array} \right\}$$

(Contractor's abstract, modified)

2185

Washington U. Dept. of Physics, St. Louis, Mo.

A MEASUREMENT OF THE LONGITUDINAL POLARIZATION OF Pr^{144} BETA-PARTICLES, by W. A. Mehlhop. Feb. 22, 1960, 106p. incl. diagrs. tables. (Technical rept. no. 26) (AFOSR-TN-59-1323) (AF 18-603)108 AD 234106; PB 147144 Unclassified

A precision determination of the longitudinal polarization of the β -particles from radioactive Pr^{144} is reported. The β -transition in Pr^{144} being of the kind $O^- \rightarrow O^+$, a potential presence of the pseudoscalar interaction type in β -decay would make itself felt in the predominant order of forbiddenness, a well known theoretical result. According to the "post-parity" formulation of the theory of β -decay, the presence of the P-interaction would, in particular, result in a decrease of the degree of longitudinal polarization of the emitted betas. Thus a precise measurement of the electron polarization allows one to draw conclusions upon the absence or presence of the P-interaction. (Contractor's abstract)

2186

Washington U. [Dept. of Physics] St. Louis, Mo.

LONGITUDINAL POLARIZATION OF ELECTRONS FROM HOLMIUM-166 (Abstract), by T. A. Pond, W. A. Mehlhop, and E. D. Lambe. [1959] [1]p. [AF 18(603)-108] Unclassified

Presented at meeting of the Amer. Phys. Soc., Gatlinburg, Tenn., Oct. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 77, Jan. 28, 1959.

A comparison of the longitudinal polarization of the beta-particles from P-32 and 27 hr Ho-166 has been undertaken. Earlier work has shown that the polarization in P-32 is $-(v/c \pm 6\%)$. Ho-166 decays in 2 branches of about equal intensity with endpoints that differ from P-32's by less than 10%. One branch is first forbidden, unique, and may be assumed to show polarization $-v/c$. The other is first forbidden, A or P. The comparison is made by Møller scattering with a geometry similar to Frauenfelder's. The scatterer is 3.6 mgm/cm² Supermendur magnetized to saturation (about 14,500 gauss) and mounted at 30° to the incident beam. Pairs

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of scattered and struck electrons with energies greater than 330 kev emerging from the foil at $(31 \pm 6)^\circ$ to the direction of the incident beam are detected by 2 plastic scintillation spectrometers with fast-slow coincidence electronics. The change in counting rate when the magnetic field is reversed, after subtraction of the experimentally determined background, is $(8.41 \pm 0.38)\%$ for P-32, and $(8.14 \pm 0.73)\%$ for Ho-166. The electron helicity is negative in both cases.

2187

Washington U. [Dep't. of Physics] St. Louis, Mo.

LONGITUDINAL POLARIZATION OF POSITRONS FROM NEON-19 (Abstract), by E. D. Lambe, J. B. Reynolds and others. [1959] [1]p. [AF 18(603)108] Unclassified

Presented at meeting of the Amer. Phys. Soc., Gatlinburg, Tenn., Oct. 27-29, 1958.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 77, Jan. 28, 1959.

About 1 mc of Ne-19 is maintained continuously in a 50 cm^3 chamber between the poles of an electromagnet. The chamber is viewed from either end through the pole tips (2-in. of saturated Armco) by 2 1-in. $\text{Dx } 1\frac{1}{2}$ -in. NaI scintillation spectrometers biased to record only γ -rays of greater than a certain energy, E_0 . This bias is usually set above 0.51 mev so that only the γ -ray emitted into the hemisphere around the momentum of a positron annihilating in flight can be recorded. If the positron is longitudinally polarized, this γ -ray is circularly polarized: for positive positron helicity, LCP. Because of the electron spin dependence of the Compton scattering of such γ -rays in the poles, the 2 counting rates show an asymmetry which reverses when the direction of magnetization is reversed. This asymmetry is $(1.60 \pm 0.18)\%$ for $E_0 = 1.3 \text{ mev}$, $(1.25 \pm 0.19)\%$ for $E_0 = 1.0 \text{ mev}$, $(0.86 \pm 0.16)\%$ for $E_0 = 0.75 \text{ mev}$, $4(0.11 \pm 0.05)\%$ for $E_0 = 0.35 \text{ mev}$. The asymmetries to be expected from full positron polarization, v/c , have been calculated from the differential cross sections for the production of RCP and LCP γ -rays from positrons which annihilate isotropically. The agreement with the observed asymmetries is excellent.

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Washington U. [Dept. of Physics] St. Louis, Mo.

POLARIZATION OF COSMIC-RAY MUONS AT SEA LEVEL (Abstract), by C. S. Johnson. [1959] [1]p.

(Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)108], Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., Cleveland, Ohio, Nov. 27-28, 1953.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 402, Nov. 27, 1959.

Cosmic-ray muons at sea level are known to be partially longitudinally polarized. The object of this experiment was to measure the muon polarization by stopping the muons in a copper absorber and observing the up:down asymmetry in the decay electrons. Measurements were also made with iron and sulfur as control absorbers to test the asymmetry of the apparatus. Since this experiment is performed in zero magnetic field it has been possible to verify that unmagnetized iron depolarizes muons by precessing their magnetic moments in the strong randomly oriented magnetic fields of the domains. The up:down ratio of decay electrons was 1.14 ± 0.02 for copper, 0.98 ± 0.02 for iron, and 1.02 ± 0.03 for sulfur. On the basis of the 2-component neutrino theory the muon polarization is found to be $> 21 \pm 3\%$, where the inequality is due to depolarization effects. There is evidence that, in the absence of external magnetic fields, copper depolarizes the stopped muons, as indicated by a decrease in the up:down ratio with time.

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Washington U. [Dept. of Physics] St. Louis, Mo.

HYPERFINE SPECTRA OF SOME DEUTERIUM SUBSTITUTED TRIPHENYLMETHYLS, by D. C. Reitz. [1959] [1]p. (Technical rept. no. 26) (AFOSR-TN-59-392) (AF 49(638)464) AD 243091 Unclassified

Also published in Jour. Chem. Phys., v. 30: 1364-1365, May 1959.

The proton hyperfine spectra of triphenylmethyl and phenyl-bis-(p-deuteriophenyl) methyl were compared. These results and those obtained with diphenyl-m-deuteriophenylmethyl indicate that the Brovetto and Ferroni splitting constants are preferred over the splitting constants assigned by Lupinski.

2190

Washington U. [Dept. of Physics] St. Louis, Mo.

POSSIBLE SYMPTOM OF THE JAHN-TELLER EFFECT IN THE NEGATIVE IONS OF CCRONENE AND TRIPHENYLENE, by M. G. Townsend and S. I. Weissman. [1959] [1]p. incl. diag. (Technical rept. no. 29) (AFOSR-TN-59-1258) (AF 49(638)464) AD 243091 Unclassified

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Also published in Jour. Chem. Phys., v. 32: 309-310, Jan. 1960.

Anions of coronene, triphenylene, benzene, and anthracene were produced by reduction with Li, Na, or K. Electron-spin resonance absorption spectra were given. The unusually broad lines of the coronene and triphenylene ions may be associated with Jahn-Teller distortions.

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Washington U. [Dept. of Physics] St. Louis, Mo.

DETERMINATION OF RATES AND MECHANISMS BY ELECTRON SPIN RESONANCE, by S. I. Weissman. [1959] [4]p. (Technical rept. no. 30) (AFOSR-TN-59-1325) (AF 49(638)464) AD 243091 Unclassified

Also published in Zeitschr. Elektrochem., v. 64: 47-50, 1960.

The occurrence of events with characteristic times in the range 10^{-9} to 10^{14} seconds may produce observable effects on electron spin resonance spectra. In some cases detailed information concerning mechanisms, not accessible to standard kinetic methods, may be obtained. Several cases of the use of electron spin resonance for these purposes are described. (Contractor's abstract)

2192

Washington U. Dept. of Chemistry, Seattle.

METALLIC REFLECTION FROM MOLECULAR CRYSTALS, by B. C. Cox and W. T. Simpson. [1958] [11]p. incl. diagrs. [AF 18(600)375] AD 247855 Unclassified

Also published in Rev. Modern Phys., v. 32: 466-476, Apr. 1960.

The molecular crystals of predominantly 1,5-bis-(dimethylamino)pentamethinium perchlorate (BDP) and auramine perchlorate were studied. By use of a special spectrometer, a BDP crystal showed fluorescence at 500-550 mμ, with a maximum at 525 mμ. The density of BDP was 1.311 ± 0.001 g/cc. The single-molecular absorption at 409 mμ has an integrated intensity corresponding to a transition moment length of 2.04 Å. A one-dimensional oscillator strength of 3.31 is computed from this length. The transition moment lengths of f values for the weak absorptions at 255 and 225 mμ are 0.34 and 0.32 Å; this corresponds to f values each of 0.15. The half-width of the single-molecular absorption at 409 mμ was 0.374×10^{15} (units of ω , the circular frequency). For face 1 of BDP, ω^2 is estimated to be 19.4×10^{30} . The corresponding dif-

ference in the ω values taken at the same points is 2.98×10^{15} . As for auramine perchlorate, a typical spectrum is given. Work done on it is published separately.

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Washington U. Dept. of Chemistry, Seattle.

HÜCKEL THEORY: AN EFFECTIVE HAMILTONIAN, by W. D. Jones. [1959] [3]p. (AF 18(600)375) AD 259224 Unclassified

Published in Jour. Chem. Phys., v. 31: 1317-1319, Nov. 1959.

An effective one-electron Hamiltonian for molecules is presented that gives exactly the single-atom energies for its diagonal elements. An operator is used that selectively cancels the nuclear attraction for all nuclei except the one on which a particular AO is centered. (Contractor's abstract)

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Washington U. Dept. of Chemistry, Seattle.

EVALUATION OF ONE-CENTER ELECTRON REPULSIVE INTEGRALS BETWEEN CERTAIN s-TYPE ATOMIC ORBITALS, by W. D. Jones and F. L. Brooks, Jr. [1959] [3]p. (AF 18(600)375) AD 247854 Unclassified

Published in Jour. Chem. Phys., v. 32: 124-126, Jan. 1960.

A general formula is derived for one center s-type electron repulsion integrals for the set of basic atomic orbitals which involve the complete set of associated Laguerre functions of order $(2l + 1)$ and degree $(n + l + 1)$ with a single orbital exponent. (Contractor's abstract)

2195

Washington U. Dept. of Chemistry, Seattle.

RESEARCH IN HETEROGENEOUS CATALYSIS, by G. D. Halsey, Jr. [Final rept.] Sept. 15, 1953-Sept. 15, 1959, 8p. incl. refs. (AFOSR-TR-59-127) (AF 18(600)-987) AD 226963; PB 143909 Unclassified

A summary of the present status of this research is presented. The 1st paper (WAU.02:001, Vol. I) is a study of the relationship of the adsorption of hydrogen to the activity of the catalyst for the conversion of parahydrogen. This system is an ideal 1 for the elucidation of the catalytic process, because the isotherms that hold during reaction are not affected by the reaction. The results of the study, however, fail to reveal

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any outstanding simplifications that would serve to elucidate a mechanism. Two other papers (WAU.02: 002, Vol. I and WAU.02: 005, Vol. II) represent a detailed study of the adsorption of rare gases on well characterized and pure surfaces. The latter of these presents extensive data for the adsorption of a gas, krypton, on a wide variety of surfaces, especially on evaporated metal films. The outstanding observation is that metals behave like insulators with respect to their interaction with the rare gas. The former paper shows that at best, the BET surface area techniques, and allied estimates, are reliable to 10%, with possible absolute error of 25%. This paper and another (WAU. 02:007, Vol. II) are the 1st fruits of the work on the high precision adsorption studies, being carried out in what is essentially a gas thermometer filled with a solid whose surface interacts with the chosen gas. Two other papers (WAU.02: 003 and 008, Vol. II) are devoted to the study of the solid solution argon-krypton, one of the simplest binary systems known that deviates from ideality. The 1st of these is an attempt to study the critical region for phase separation of this system by conventional means. In the other, an entirely new and improved method of studying the solution is presented. The last paper reported on (WAU.02: 004, Vol. II) is a study of the simplest possible Henry's law region, the solution of helium in argon.

2196

Washington U. Dept. of Chemistry, Seattle.

AUTOMATIC SLIT DRIVE FOR INFRARED SPECTROMETERS, by D. F. Eggers, Jr. and M. T. Emerson. Mar. 8, 1960 [3]p. incl. diagrs. table. (Technical note no. 5) (AFOSR-TN-59-146) (AF 18(600)1522) AD 234127 Unclassified

Also published in Jour. Opt. Soc. Amer., v. 50: 11-13, Jan. 1960.

An automatic slit drive has been constructed for a single-beam infrared spectrometer, using two helical potentiometers in a servosystem. The output of generator potentiometer is heavily loaded causing its output voltage function to curve sharply with displacement. This reduces the number of taps per prism to 2. Evaluation of circuit parameters is described, and values are listed for prisms of calcium fluoride, sodium chloride, potassium bromide, and cesium bromide, used in double pass. A simple modification permits selection of several different energy levels. The resulting curves of spectrometer output vs frequency are constant. (Contractor's abstract)

2197

Washington U. Dept. of Chemistry, Seattle.

INFRARED INTENSITIES OF SULFUR DIOXIDE: A RE-DETERMINATION, by D. F. Eggers, Jr. and

E. D. Schmid. [1959] [2]p. incl. diagr. table. (Technical note no. 6) (AFOSR-TN-59-881) (AF 18(600)1522) AD 234579; PB 145678 Unclassified

Also published in Jour. Phys. Chem., v. 64: 279-280, Feb. 1960.

Infrared intensity measurements have been reported for the 3 fundamentals of sulfur dioxide in the gas phase by 3 independent groups. Since those of this laboratory were much lower than those of the other 2 groups, the intensities have been remeasured here; the new results are in agreement with those of the other 2 groups. Possible reasons for this discrepancy are discussed. (Contractor's abstract)

2198

Washington U. Dept. of Chemistry, Seattle.

KINETICS AND EQUILIBRIA IN THE ALKYLATION OF DIBORANE, I, by L. Van Alten, G. R. Seely and others. Preliminary rept. June 25, 1959 [14]p. incl. diagrs. table. (AFOSR-TN-59-311) (AF 18(600)1541) AD 213243; PB 142299 Unclassified

Presented at meeting of the Div. of Inorg. Chem. of the Amer. Chem. Soc., San Francisco, Calif., Apr. 13-18, 1958.

Abstract published in 133rd meeting of the Amer. Chem. Soc. Abstracts of Papers, 1958, p. 38-L.

Also published in Adv. in Chem. Ser., No. 32: 107-114, 1961.

Studies were made of the reaction between B_2H_6 and trimethylborane, and the decomposition of monomethyl diborane (B_2H_5Me). Gas partition fractometry was used for analysis. Aliquots were removed at intervals from the reaction vessel for analysis by expansion into a small adjacent volume from which they were swept directly into the fractometer. The quantities present were estimated by graphical integration of the fractometer patterns. The areas where curves overlapped was estimated by comparison with curves obtained for each substance alone. The areas were corrected by factors proportional to the relative thermal conductivities with $B_2H_6:B_2H_5Me:BMe_3:B_2H_4Me_2$ as 1:1.23:1.42:1.42. The average 2nd-order velocity constant, determined graphically, was 0.40 l/min mol with an average deviation of 0.02. After several days, the reaction mixture reached a steady state, apparently an unchanging composition of B_2H_6 , B_2H_5Me , and 1,1-dimethyldiborane. With respect to the reaction, $B_2H_6 + \frac{1}{2} 1,1-B_2H_4Me_2 \rightleftharpoons \frac{1}{2} 1,2-B_2H_4Me_2 + 2B_2H_5Me$, equilibrium constant values of 0.35 and 0.65 at 0° were obtained from mixtures established from $B_2H_6-BMe_3$ and $B_2H_6-B_2H_4Me_2$.

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respectively. The decomposition of B_2H_5Me was a 1st-order reaction. The equilibrium constant values for the reaction $B_2H_5Me = B_2H_6 + (BH_2Me)_2$, were calculated.

2199

Washington U. Dept. of Chemistry, Seattle.

GAS-LIQUID FRACTOMETRIC ANALYSIS OF MIXTURES CONTAINING METHYLDIBORANES, by G. R. Seeley, J. R. Oliver, and D. M. Ritter. June 25, 1959 [6]p. incl. diagr. tables. (AFOSR-TN-59-398) (AF 18-600)1541 AD 214518; PB 142300 Unclassified

Also published in Anal. Chem., v. 31: 1903-1995, Dec. 1959. (Title varies)

The specific retention volumes, V_g , have been determined as functions of temperature for diborane, trimethylborane and the methyldiboranes on columns packed with mineral oil on pulverized fire-brick. Column efficiency was not great, but sufficient to permit almost complete separation of the elution curves at 0°C and the quantitative determination of the substances to an accuracy of 1-2% of the amounts present in a mixture. Extensive investigation of the equilibria and kinetics of formation and interconversion of the methyldiboranes has become possible through application of the gas-liquid partition fractometer as a quantitative analytical device. The results of such measurements are to be published elsewhere; the purpose of this contribution is to describe the analytical method itself. The commonly known boron hydrides have been observed qualitatively in this manner by Koski and his coworkers, and the selection of a suitable fluid for separation of the methyldiboranes was based upon those results. (Contractor's abstract)

2200

Washington U. Dept. of Chemistry, Seattle.

CALCULATION OF DELOCALIZATION CONTRIBUTION TO INFRARED INTENSITY, by W. D. Jones and W. T. Simpson. [1959] [10]p. incl. tables. (AFOSR-TN-59-1329) [AF 49(638)677] AD 247853 Unclassified

Also published in Jour. Chem. Phys., v. 32: 1747-1756, June 1960.

Infrared intensity may be related to energies and intensities of electronic transitions by using the theory of the vibrational perturbation of electronic transitions and holding the electronic state quantum number fixed. This suggests in particular relating the infrared intensity of an appropriate normal mode to the strong ultraviolet absorption in dye-like molecules having conjugated π -electron systems. The perturbation theory is tested by applying it to a displaced hydrogen atom and the hydrogen molecule ion. The results suggest the need for modifying the theory to employ floating orbitals. A floating orbital theory of infrared intensity which still brings in ultraviolet transition energies and moments is then constructed. This theory is next applied to the model compounds H_3^+ , H_5^+ and H_7^+ and there is predicted an extraordinarily high delocalization contribution to the intensity for the anti-symmetric stretch. Values for the dipole derivatives are calculated ranging up to 65 debyes/A. (Contractor's abstract)

drogen atom and the hydrogen molecule ion. The results suggest the need for modifying the theory to employ floating orbitals. A floating orbital theory of infrared intensity which still brings in ultraviolet transition energies and moments is then constructed. This theory is next applied to the model compounds H_3^+ , H_5^+ and H_7^+ and there is predicted an extraordinarily high delocalization contribution to the intensity for the anti-symmetric stretch. Values for the dipole derivatives are calculated ranging up to 65 debyes/A. (Contractor's abstract)

2201

Washington U. Dept. of Chemistry, Seattle.

THE SOLUBILITY, ACTIVITY COEFFICIENT AND HEAT OF SOLUTION OF SOLID XENON IN LIQUID ARGON, by W. H. Yunker and G. D. Halsey, Jr. [1959] 3p. incl. diagrs. (Technical note no. 1) (AFOSR-TN-59-1210) (AF 49(638)723) AD 242750 Unclassified

Also published in Jour. Phys. Chem., v. 64: 484-486, Apr. 1960.

The liquid solutions of Xe in Ar and Kr in Ar and the solid solution of Ar in Xe have been studied in the temperature range 84.0 - 87.5°K., using vapor pressure measurements. The solubility of Xe in Ar was found to be $4.14 - 5.01 \pm 0.03$ mol % Xe and the partial molar heat of solution of Xe in the infinitely dilute solution was found to be 632 ± 70 cal. per mol. For $\mu_{Xe} - \mu_{Xe}^0 = RT \ln n_{Xe} + \alpha(1 - n_{Xe})^2$, $\alpha = 535 \pm 58$ cal per mol. No saturation of Kr in Ar was reached in this region (up to 4.7%); $\alpha = 146 \pm 30$ cal/mol. Argon was found to be less than 0.5% soluble in solid xenon. (Contractor's abstract)

2202

Washington U. [Dept. of Physics] Seattle.

JUMPING RATE OF DEUTERONS BETWEEN THE HYDROGEN BONDS OF KD_2PO_4 (Abstract), by V. H. Schmidt and E. A. Uehling. [1959] [1]p. [AF 49(638)-92] Unclassified

Presented at meeting of the Amer. Phys. Soc., California Inst. of Tech., Pasadena, Dec. 28-30, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 462, Dec. 28, 1959.

There are 4 principal lines in the magnetic resonance spectrum of deuterons in KD_2PO_4 . If 1 of these lines is saturated other lines are enhanced or saturated in a definite way. An effective exchange of deuterons between nonequivalent positions can cause the observed

phenomena, but spin exchange cannot. The effective time τ_c of spatial exchange was measured directly using pulse methods. A value of about 0.4 sec was found for τ_c at 25°C. It decreases rapidly with increase in temperature, reaching a value of 0.015 sec at 70°C. The relaxation time T_1 decreases simultaneously by a factor of less than 2. The dependence of τ_c on temperature suggests barrier penetration with an activation energy of about 0.6 ev. The value found for τ_c , and failure of T_1 to change proportionally to τ_c , are not in accord with a relaxation model suggested previously, based on deuteron jumps and the quadrupole interaction from which the smaller value of $\tau_c = 5 \times 10^{-3}$ sec was deduced.

2203

Wayne State U. [Dept. of Mathematics] Detroit, Mich.

GROUPS OF AUTOMORPHISMS OF KAEHLER MANIFOLDS, by S. I. Goldberg. July 1959, 7p. (AFOSR-TN-59-797) (AF 49(638)14) AD 227350; PB 143953

Unclassified

Also published in Bull. Amer. Math. Soc., v. 66: 54-58, Jan. 1960. (Title varies)

A. Lichnerowicz proved that the largest connected Lie group of conformal transformations of a compact Einstein-Kaehler space M^{2k} ($k > 1$) leaves invariant the Kaehlerian structure. In this report the following much stronger result is obtained: The largest connected Lie group of conformal transformations of a $4k$ -dimensional compact Kaehler manifold coincides with the largest connected group of automorphisms. Theorems of a less general nature but with no restriction on the dimension of the manifold are also obtained. These results can be partially extended to the open Kaehlerian manifolds and hold also for those symplectic manifolds in which the fundamental exterior 2-form is harmonic. (Contractor's abstract)

2204

Wayne State U. Dept. of Mathematics, Detroit, Mich.

RELATION BETWEEN ABSTRACT HOMOTOPY AND GEOMETRIC HOMOTOPY, by S. Verma. Mar. 1959, 117p. incl. diagrs. (Technical note no. 3) (AFOSR-TN-59-126) (AF 49(638)179) AD 210614; PB 142239

Unclassified

An actual construction of an abstract homotopy theory for the category of Kan complexes and Kan maps is described. Both the relative and the absolute homotopy groups are considered. An axiomatization of the theory is given and its uniqueness is established. How ho-

motopy and singular (co-) homology groups of a topological space may be defined from those of cubical complexes by applying the cubical singular functor is shown. A complete semi-simplicial singular functor is described to define a homotopy notion on A (the category of topological spaces) in terms of the homotopy notion on K (the category of Kan complexes and Kan maps). The homotopy groups of topological spaces are shown to be isomorphic to those of the total singular complexes of these spaces.

2205

Wayne State U. Dept. of Mathematics, Detroit, Mich.

ON THE UNIQUENESS THEOREM OF LOCAL HOMOMLOGY THEORY, by S.-T. Hu. Mar. 1959, 13p. incl. refs. (Technical note no. 4) (AFOSR-TN-59-204) (AF 49(638)179) AD 211609; PB 142237

Unclassified

Also published in Tsing hua Jour. Chinese Studies, Special no. 1 (Natural Sci.): 192-200, Dec. 1959.

In a recent paper of T. R. Brahana, (Duke Math. Jour., v. 25: 381-400, 1959) an axiomatic approach to the local homology theory is given and the uniqueness theorem is established for the category of the triangulable local pairs. His methods of proof are parallel to those used by Eilenberg and Steenrod (Foundations of Algebraic Topology, Princeton, 1952) in the global homology theory. If one applies the global uniqueness theorem of Eilenberg and Steenrod instead of paraphrasing their methods, the proof of the local uniqueness theorem would be much simpler. In the present technical note such a proof is produced. (Contractor's abstract)

2206

Wayne State U. Dept. of Mathematics, Detroit, Mich.

ISOTOPY INVARIANTS OF TOPOLOGICAL SPACES, by S.-T. Hu. Mar. 1959, 69p. incl. diagrs. (Technical note no. 5) (AFOSR-TN-59-236) (AF 49(638)179) AD 212096; PB 142025

Unclassified

Also published in Proc. Royal Soc. (London), v. 255A: 331-366, Apr. 19, 1960.

An attempt was made to introduce and study new algebraic isotopy invariants of spaces. A general method of constructing isotopy invariants is given by means of a certain class of functors as follows. A functor F from a category C of spaces and maps into another such category D is said to be an isotopy functor if F carries isotopies into isotopies. If F is an isotopy functor from C into D and if X is a space in C , then the homotopy invariants of the space $F(X)$ are isotopy invariants of the given space X . Special isotopy functors are constructed, namely, the m -th residual functor R_m and the m -th enveloping functor E_m . The

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homology groups obtained by using these special functions are proved to be finitely computable. Applications of these isotopy invariants to linear graphs are given. Results show that these invariants can distinguish various spaces belonging to the same homotopy type. (Contractor's abstract)

2207

Wayne State U. Dept. of Mathematics, Detroit, Mich.

HOMOTOPY AND ISOTOPY PROPERTIES OF TOPOLOGICAL SPACES, by S.-T. Hu. Nov. 1959, 23p. (Technical note no. 6) (AFOSR-TN-59-1108) (AF 49(638)179) AD 231386; PB 145515 Unclassified

Also published in *Canad. Jour. Math.*, v. 13: 167-176, 1961.

The general tests for homotopy and isotopy properties of topological spaces are established in terms of hereditary and weakly hereditary properties. A general method of constructing new boundary and isotopy invariants of topological spaces are described.

2208

Wayne State U. [Dept. of Physics] Detroit, Mich.

DIFFUSION OF HYDROGEN IN GERMANIUM (Abstract), by R. C. Frank and J. E. Thomas, Jr. [1959] [1]p. [AF 49(638)158] Unclassified

Presented at meeting of the Amer. Phys. Soc., Cleveland, Ohio, Nov. 27-28, 1959.

Published in *Bull. Amer. Phys. Soc.*, Series II, v. 4: 411, Nov. 27, 1959.

Single crystal germanium diffusion specimens were prepared by a technique similar to that previously used for silicon by Van Wieringen and Warmoltz. The hollow cylindrical specimens were sealed at 1 end and attached to a mass spectrometer at the other. By surrounding the thin cylinder with hydrogen gas and observing it diffuse through into the mass spectrometer, permeation rates and diffusion coefficients were measured in the temperature range of 800 to 910°C. The excellent agreement between diffusion coefficients measured by the "delay time" and decay curve methods indicates that trapping effects by lattice defects were small or non-existent. At 800°C the diffusion coefficient was 4.7×10^{-5} cm²/sec and the solubility was 6.0×10^{13} atoms/cc. The activation energy for diffusion is 8.7 ± 0.8 kcal/g atom and the heat of solution is 52.8 ± 1.4 kcal/g atom. The permeation rate was found to vary as the square root of the gas pressure which indicates that the hydrogen exists in the germanium lattice as hydrogen atoms or ions.

2209

Weizmann Inst. of Science, Rehovot (Israel).

AN NMR STUDY OF THE PROTOLYSIS KINETICS IN METHANOL AND ETHANOL, by Z. Luz, D. Gill, and S. Meiboom. [1959] 23p. incl. diagrs. tables, refs. (AFOSR-TN-59-19) (AF 61(052)00) AD 208600 Unclassified

Also published in *Jour. Chem. Phys.*, v. 30: 1540-1545, June 1959.

Measurements by the nuclear magnetic resonance (NMR) technique of the hydrogen exchange kinetics in methanol and ethanol are reported. The exchange reaction is both acid and base catalyzed. The observed kinetics can be interpreted as a simple proton transfer between a neutral alcohol molecule and an alcoxonium, or alcoxyde ion respectively. In methanol a third mechanism, not involving ions, was also observed. In ethanol this reaction is presumably too slow for detection by the NMR technique. The hydrogen exchange was also studied in alcohol-water mixtures. Possible exchange mechanisms are discussed and values for their respective rate constants are given. (Contractor's abstract)

2210

Weizmann Inst. of Science, Rehovot (Israel).

TABLES OF EXCHANGE BROADENED N-M-R MULTIPLETS. [1959] 56p. incl. tables. (Technical note no. 2) (AFOSR-TN-59-292) (AF 61(052)03) AD 213032; PB 140692 Unclassified

Tables are given for calculated absorption lineshapes of NMR multiplets as function of exchange rate of the interacting nuclei. The equations on which the tables are based have been derived on the following assumptions: (1) chemical shift large compared to spin-spin interaction; (2) nuclei with spin 1/2; (3) absence of saturation; and (4) the duration of the exchange reaction can be neglected compared to the mean lifetime.

2211

Weizmann Inst. of Science. Dept. of Applied Mathematics, Rehovot (Israel).

NATURE OF THE SINGULARITIES IN THE SPECTRUM OF A ONE-DIMENSIONAL IONIC LATTICE, by J. Gillis and G. Weiss. [1959] [2]p. [AF 61(514)899] Unclassified

Published in *Phys. Rev.*, v. 115: 1520-1521, Sept. 15, 1959.

It is known, by a theorem of van Hove, that regular lattices have singularities in their frequency spectra, the type of singularity depending on the dimension.

Although several studies of the 1-dimensional lattice with Coulomb interactions have appeared, no one yet has succeeded in identifying the type of singularity that appears in addition to the inverse square root singularity, in the frequency spectrum. In this note we establish that for a 1-dimensional crystal the singularity is of the form $g(\omega) \sim [(\omega - \omega_1) \ln[1/(\omega - \omega_1)]]^{\frac{1}{2}}$ where A is a constant and ω_1 is the position of the singularity. (Contractor's abstract)

2212

Western Reserve U. [Dept. of Physics] Cleveland, Ohio.

LOW-INTENSITY CONVERSION LINES IN TWO WEAKLY DEFORMED NUCLEI, by W. T. Achor, W. E. Philips and others. May 12, 1959 [29]p. incl. diagrs. tables, refs. (AFOSR-TN-59-433) (In cooperation with Vanderbilt U.) (Sponsored jointly by Air Force Office of Scientific Research under AF 18(603)61 and Atomic Energy Commission under AT(40-1)268 and AT(4J-1)-1322) AD 214795; PB 143070 Unclassified

Also published in Phys. Rev., v. 114: 137-142, Apr. 1, 1959. (Title varies)

The electron spectrum of Sm^{151} has been measured with a lens spectrometer and its gamma-ray spectrum with a scintillation spectrometer. The L-conversion coefficient of the 21.7 ± 0.3 kev α -excitation of the first excited state of Eu^{151} is 20 ± 4 , with $\alpha_L/\alpha_{M+N} = 2.2 \pm 0.4$ and $\alpha_M/\alpha_N = 2.2 \pm 0.2$ indicating M1 multipolarity. The low intensity of the conversion electrons relative to the continuous beta spectrum of end point 75.9 ± 0.6 kev implies the existence of a weak beta transition whose end point is 54.2 ± 0.7 kev. The beta branching ratio 54.2-kev beta transitions/75.9 kev beta transitions is 1.7/100. \log_{10} ft values for the two beta decays are 7.6 ± 0.2 for the 75.9-kev decay and 8.8 ± 0.2 for the 54.2 kev decay. A partial analysis of the decay in terms of the Nilsson-Gottfried scheme has been made, but no definitive assignment for the 21.7-kev state appears to be possible. Measurements of the electron spectrum of Sn^{113} with the lens spectrometer reveal the existence of a weak conversion line corresponding to a transition of 253 kev. The intensity of this conversion line is $(2.8 \pm 1.0) \times 10^{-3}$ of the intensity of the conversion line from the 392-kev transition. This relative conversion electron intensity indicates that the 253-kev transition leads to the 392-kev state of In^{113} , implying the existence of an excited state at 645 kev. The existing uncertainty in the relative gamma-ray intensities for the 2 transitions makes it impossible to assign spin and parity to the 645-kev state; the decay scheme presented is therefore incomplete. (Contractor's abstract)

2213

Western Reserve U. Dept. of Physics, Cleveland, Ohio.

FITTING OF TABULATED DATA TO AN ANALYTIC FORM, by V. F. Walters and G. E. Tauber. July 31, 1959 [7]p. incl. tables. (AFOSR-TN-59-736) (AF 18(603)61) AD 220083; PB 142921 Unclassified

A study is presented for finding an analytic function to fit a given set of tabulated values for K and L wave functions. It was desirable to find a minimum number of parameters which determine an analytic form that has approximately the same behavior as the original set of values. A method which produces good results with satisfactory accuracy depends on integrating the function over all points. Such integrations lead to a system of exact equations for the parameters. The method is simple and straightforward and should lend itself equally well to similar problems. The method of least squares was also used, and satisfactory results were obtained for some functions (Contractor's abstract)

2214

Western Reserve U. [Dept. of Physics] Cleveland, Ohio.

ON THE HALF-LIFE OF Tl^{204} , by R. W. Fink and B. L. Robinson. [1959] [6]p. incl. tables, refs. (In cooperation with Arkansas U.) [AF 18(603)61] Unclassified

Published in Nuclear Phys., v. 10: 82-89, Feb. 1959.

Samples of Tl^{204} produced in different irradiations and of varying ages were counted in an end-window methaneflow beta-proportional counter for a period of 1.4 yr. The decay curves for these samples are identical, and the average value of the half-life is 3.78 ± 0.04 yr. Intercomparison of the ratio of K x-rays to beta-bremsstrahlung and of L x-rays to beta-bremsstrahlung between young (few mo) and aged (6 yr) reactor-produced, high specific activity solutions of Tl^{204} exhibited no differences which might arise from the presence of a long-lived isomeric state in thallium. Previous results are summarized. (Contractor's abstract)

2215

Western Reserve U. [Dept. of Physics] Cleveland, Ohio.

NUCLEAR STRUCTURE EFFECTS IN INTERNAL CONVERSION COEFFICIENTS BY CONFIGURATION MIXING, by L. S. Kisslinger. [1959] [13]p. incl. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(603)61] and Oak Ridge Inst. of Nuclear Studies) Unclassified

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Published in Phys. Rev., v. 114: 292-304, Apr. 1, 1959.

The nuclear matrix elements which are needed to determine the internal conversion coefficients when a finite nucleus is employed are derived for nuclei for which the shell model wave functions are a good zero-order approximation for low-energy processes. Using configuration mixing, general expressions are derived for these matrix elements. It is shown that the nuclear structure alteration can be 10 to 20% or more for 1-forbidden transitions. Numerical results are given for the M1 and E2 279-kev transitions in Ti^{203} . (Contractor's abstract)

2216

Western Reserve U. School of Library Science,
Cleveland, Ohio.

THE STORAGE AND RETRIEVAL OF NONNUMERICAL DATA IN LARGE AND COMPLEX DOCUMENTATION SYSTEMS, by A. Kent and J. W. Perry. Feb. 24, 1959, 25p. incl. diagr. (Technical note no. 6) (AFOSR-TN-59-82) (AF 49(638)357) AD 210142; PB 151639

Unclassified

Presented at meeting of the Amer. Soc. Mech. Engineers, Cleveland, Ohio, Mar. 30, 1959.

The introduction of automatic routines for the precise selection of pertinent information from large document collections covering broad areas of subject matter requires a careful analysis of the input and output phases of the documentation system used. A simplified model has been hypothesized to provide a universe of information with which to study various information retrieval systems, and to provide a basis for characterizing and later identifying information which involves no uncertainty. Some of the problems involved when uncertainty is introduced are discussed in qualitative terms. (Contractor's abstract)

2217

Western Reserve U. School of Library Science,
Cleveland, Ohio.

THE PROCESSES OF DOCUMENTATION, by R. E. Booth and H. M. Wadsworth. Feb. 18, 1959, 29p. incl. diagrs. tables, refs. (Technical note no. 7) (AFOSR-TN-59-222) (AF 49(638)357) AD 211804; PB 142296

Unclassified

A documentation system is defined as a complex pattern of interacting and interdependent processes which facilitates the use of recorded specialized knowledge through its presentation, reproduction, publication, dissemination, acquisition, characterization, storage, and retrieval. These processes are divided into 2 categories: (1) processes over which the documentalist normally exercises little or no control; and (2)

processes over which the documentalist exercises a high degree of control. The latter group is the main subject of this paper. The processes are described verbally, then symbolized for statistical formulation. Statistical models are developed. A confidence interval for estimating the number of items available on a given subject is presented as part of the analysis of the acquisition process. Characterization, storage, and retrieval are examined from the point of view of sets and transformations which, in turn, are described in terms of Boolean algebra. (Contractor's abstract)

2218

Western Reserve U. School of Library Science,
Cleveland, Ohio.

THE APPLICATION OF STATISTICAL DECISION THEORY TO PROBLEMS OF DOCUMENTATION, by H. M. Wadsworth and R. E. Booth. Mar. 9, 1959, 24p. incl. diagrs. tables. (Technical note no. 8) (AFOSR-TN-59-418) [AF 49(638)357] AD 215225; PB 142340

Unclassified

The application of statistical decision theory to documentation processes is considered. Choices of action in information retrieval situations are described and discussed quantitatively. Game theory is used to solve an illustrative problem involving documentalist's decision to stop or to continue searching. The players in this theoretical game are Nature and the documentalist. The documentalist used Bayes' solution to evaluate alternative strategies with Nature's strategies restricted. Concept of loss function based on utility theory is introduced. (Contractor's abstract)

2219

Western Reserve U. School of Library Science,
Cleveland, Ohio.

MINIMUM CRITERIA FOR A COORDINATED INFORMATION SERVICE, by A. Kent. Oct. 16, 1959, 10p. incl. table. (Technical note no. 10) (AFOSR-TN-59-1140) (AF 49(638)357) AD 229882

Unclassified

Also published in Amer. Doc., v. 11: 84-87, 1960.

A set of minimum criteria for a coordinated information service was prepared in connection with various programs on the machine searching and correlation of metallurgical literature conducted by the Center for Documentation and Communication Research. Suggested criteria are listed and factors relating to these criteria which apply to the American Society for Metals pilot machine searching operation are indicated. (Contractor's abstract)

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2220

Western Reserve U. School of Library Science,
Cleveland, Ohio.

MACHINE LITERATURE SEARCHING AND TRANSLATION. AN ANALYTICAL REVIEW, by A. Kent. [1959] [224]p. incl. diagrs. tables. (Technical note no. 11) (AFOSR-TN-59-1141) (AF 49(638)357) Unclassified

Also published in *Advances in Doc. and Library Sci.*, v. 3 (Pt. 1): 13-236, 1960.

New methods and devices for the analysis and retrieval of recorded information attempt to provide a multidimensional approach to these problems. The various devices may be grouped in 6 broad classifications: (a) Hand-sorted punched cards (document system); (b) Hand-manipulated aspect cards (aspect system); (c) Machine-sorted punched cards (document or aspect systems); (d) Machine-manipulated aspect cards (aspect system); (e) Tape-reading devices (document or aspect systems); and (f) Photographic film devices (document system). Their similar or differing characteristics are described. The many approaches to problems of mechanical translation of languages are discussed, according to their various goals and differing research tactics, and common procedures and methods are outlined. The world's literature of machine searching and machine translation is reviewed.

2221

Westinghouse Electric Corp. Air Arm Div., Baltimore,
Md.

TRAJECTORY PROBLEMS IN CISLUNAR SPACE. Dec. 31, 1959, 42p. incl. diagrs. (AFOSR-TN-59-1284) (AF 49(638)490) AD 230878; PB 145477
Unclassified

A numerical investigation was conducted of the earth-moon-vehicle system as a planar, restricted 3-body problem. Analytical methods were used to determine the effects of variations in lunar orbit injection conditions upon significant orbital parameters. From these data, guidance and vernier propulsion requirements and trade-offs may be determined for specific missions in cislunar space. The significant parameter of velocity relative to the moon is also investigated. The result obtained is that the effects of a midcourse velocity correction on lunar miss distance and passing velocity are of opposite sense; that is, if one is increased the other is decreased. A velocity impulse in certain directions has no effect on either miss distance or passing velocity and that, in general, at least 2 midcourse impulses may be required to correct both of these factors. The sensitivity of terminal miss and velocity conditions to midcourse corrections in the most effective direction is quite high, varying in the case of miss distance from about 75 mi at the moon per mph correction to 20 mi per mph and in the case of passing velocity, from about 17 to 5 mph at the moon per mph correction.

2222

Westinghouse Electric Corp. Air Arm Div., Baltimore,
Md.

TECHNIQUES FOR GUIDANCE, NAVIGATION, AND COMMUNICATION IN CISLUNAR SPACE FLIGHT (Unclassified title), by G. Shapiro and J. M. Edmiston. Technical rept. Dec. 30, 1959, 54p. incl. illus. diagrs. (AFOSR-TR-59-211) (AF 49(638)490) AD 314895
Secret

2223

[Westinghouse Electric Corp.] Westinghouse Research
Labs., Pittsburgh, Pa.

IONIC PUMPING MECHANISM OF HELIUM IN AN IONIZATION GAUGE, by L. J. Varnerin, Jr. and J. H. Carmichael. [1955] [2]p. incl. diagr. [AF 18(600)1049] Unclassified

Published in *Jour. Appl. Phys.*, v. 26: 782-783, June 1955.

This report gives an explanation on the pumping of helium. The experiment utilized a Bayard-Alpert gauge which had no previous outgassing. It is shown that ions driven into a metal film cannot diffuse as freely as in glass and can be trapped. For very thin films the amount of gas depends upon the thickness of the film.

2224

[Westinghouse Electric Corp.] Westinghouse Research
Labs., Pittsburgh, Pa.

ROLE OF RE-EMISSION IN IONIC PUMPING (Abstract), by L. J. Varnerin, Jr. and J. H. Carmichael. [1955] [1]p. [AF 18(600)1049] Unclassified

Published in *Phys. Rev.*, v. 99: 1662, Sept. 1, 1955.

The ionic pumping mechanism of helium in a Bayard-Alpert ionization gauge has been investigated. The reduction in pumping speed resulting in a nonexponential pressure reduction in a closed system is shown to result from the re-emission of helium previously pumped. The rate of re-emission was determined as a function of time from 0.5 min to 5000 min after pumping a small amount of gas for 0.5 min (pressure reduction Δp mm). The re-emission rate was found to be approximately $C(\text{mm}/\text{min}) = 0.04\Delta p(\text{mm})/t^{1.1}(\text{min})$ in this time interval. It is not possible in any simple way to account for this on the basis of gas diffusing to a surface into which the ions had been driven. This phenomenological equation for the re-emission of helium is used to derive an integro-differential equation applicable to the pumping process. Within the experimental accuracy of the data, the

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equation is shown to account quantitatively for observed pumping experiments in which pressure is reduced from 8×10^{-5} mm to 3×10^{-8} mm and the effective pumping speed reduces by a factor of 400. (Contractor's abstract)

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[Westinghouse Electric Corp.] Westinghouse Research Labs., Pittsburgh, Pa.

ELECTRICAL CLEANUP OF GASES, by J. H. Carmichael. Final progress rept. Mar. 1954-Mar. 1959. May 1, 1959, 3p. (Research rept. no. 71F191-R2C) (AFOSR-TR-59-80) (AF 18(600)1049) AD 219190 Unclassified

A study of the mechanism for trapping gases as ions on metal surfaces was made. In order to separate ionic pumping from chemical absorption, only rare gases were used. In these studies it was found that the re-emission of these gases from the surface was playing an important role. A study of the ionic pumping and spontaneous re-emission of these gases has contributed considerably in an understanding of the pumping characteristics of ion pumps and ionization gauges. (Contractor's abstract)

2226

Wisconsin U. Dept. of Chemistry, Madison.

FREE RADICAL AND IONIC ADDITION REACTIONS TO CARBON-CARBON DOUBLE BOND, by H. L. Goering. Final rept. May 7, 1959 [3]p. incl. refs. (AFOSR-TR-59-38) (AF 18(600)1037) AD 213886 Unclassified

A summary of nine manuscripts published in the Jour. Amer. Chem. Soc. is presented. Included in the research project are the stereospecificity of the radical addition of HBr and sulhydryl compounds. Ionic additions are also studied and the chemistry of the more interesting adducts was investigated. Also bound in the report is part IV, The Radical Addition of Hydrogen Bromide and Deuterium Bromide to cis- and trans-2-Bromo-2-butene, of the project, Stereochemistry of Radical Additions.

2227

Wisconsin U. Dept. of Chemistry, Madison.

THE STEREOCHEMISTRY OF RADICAL ADDITIONS. IV. THE RADICAL ADDITION OF HYDROGEN BROMIDE AND DEUTERIUM BROMIDE TO CIS AND TRANS 2-BROMO-2-BUTENE, by H. L. Goering and D. W. Larsen. [1959] 25p. incl. diagrs. tables, refs. (Bound with its AFOSR-TR-59-38; AD 213866) (AF 18(600)1037) Unclassified

Also published in Jour. Amer. Chem. Soc., v. 81: 5937-5942, Nov. 20, 1959.

The radical-chain additions of HBr and DBr to the isomeric 2-bromo-2-butenes at -80° in excess liquid HBr or DBr are completely stereospecific. Under these conditions the trans-addition products are obtained. As the reaction temperature is increased, i.e., as the amount of addendum in the liquid phase decreases, the stereospecificity diminishes to the point where addition is nearly random at room temperature. Under all conditions the degree of stereospecificity appears to be about the same for HBr and DBr. The intermediate 2,3-dibromobut-2-yl radical reacts about 2,4 times faster with HBr than with DBr. Radical addition gives only 2,3-dibromobutane and ionic addition results in the exclusive formation of 2,2-dibromobutane. (Contractor's abstract)

2228

Wisconsin U. Dept. of Chemistry, Madison.

PYRIDINIUM COMPLEXES. III. CHARGE-TRANSFER BAND OF POLYALKYLPYRIDINIUM IODIDES, by E. M. Kosower and J. A. Skorz. Sept. 29, 1959 [39]p. incl. diagrs. tables, refs. (AFOSR-TN-59-811) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)282 and National Institutes of Health) AD 226713; PB 143599 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 2195-2203, May 5, 1960.

A study of the first (long wavelength) charge-transfer band of 20 different alkylpyridinium iodides under carefully standardized conditions has established that (1) increasing the number of methyl groups raises the transition energy (2) changing a methyl group from the 3- to the 4-position increases the transition energy (3) varying the nature of the alkyl group from methyl to t-butyl on the 4-position has virtually no effect upon the transition energy and (4) the solvent sensitivity of 1-methylpyridinium iodide is appreciably greater than that of 1-ethyl-4-carbomethoxypyridinium iodide, as might have been expected on the basis of a previously proposed model. The maxima observed varies from 3738A for 1-methylpyridinium iodide to 3253A for 1,2,3,4,5,6-hexamethylpyridinium iodide. Surprisingly, replacement of the 1-methyl by hydrogen moves the charge-transfer band to 3463A. Two points favor the interpretation of the effect of alkyl groups as being due to the bond dipole generated by the combination of an sp^3 bonding orbital with an sp^2 orbital: (1) the effect of the 3-methyl group can be accounted for on the basis of electrostatic stabilization of the ground state and (2) a change in the nature of the alkyl group on the 4-position does not elicit electron-supply dependent on the number of α -hydrogens, as would have been expected for hyperconjugation. It is known that the absorption bands of alkylpyridinium iodides are a transition charge-transfer from the iodide ion to the alkylpyridinium ion on the basis of solvent effects, difference in

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transition energy values, conductivity measurements, and a few substituent effects. In order to define the substituent effects on these absorption bands in a more precise manner, a series of different alkylpyridinium iodides were investigated. It was hoped that the relationships found would also cast some light upon the means by which alkyl groups supply electronic charge to electron-deficient systems. By rigid control of the many variables which affect the environment-sensitive pyridinium iodide transition, it is possible to obtain data applicable to both of these purposes.

2229

Wisconsin U. Dept. of Chemistry, Madison.

THE STUDY OF PYRIDINIUM IODIDE CHARGE-TRANSFER BANDS, by E. M. Kosower and J. A. Skorcz. Sept. 29, 1959 [9]p. incl. diagr. table, refs. (AFOSR-TN-59-812) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)282 and National Institutes of Health) AD 226711; PB 143641
Unclassified

Presented at Fourth Internat'l. meeting on Molec. Spectros., Bologna (Italy), Sept. 7-12, 1959.

Also published in *Advances in Molec. Spectros.*, v. 1: 413-417, 1962.

The general nature of pyridinium iodide light absorption is discussed. It is pointed out that the high sensitivity of this electronic transition to internal and external influences makes detailed study very rewarding with respect to information on electrical, steric, and solvent effects.

2230

Wisconsin U. Dept. of Chemistry, Madison.

PYRIDINIUM COMPLEXES. I. THE SIGNIFICANCE OF THE SECOND CHARGE-TRANSFER BAND OF PYRIDINIUM IODIDES, by E. M. Kosower, J. A. Skorcz and others. Sept. 29, 1959 [16]p. incl. diagrs. tables, refs. (AFOSR-TN-59-813) (Sponsored jointly by Air Force Office of Scientific Research under AF 49(638)282 and National Institutes of Health) AD 226712; PB 143599
Unclassified

Also published in *Jour. Amer. Chem. Soc.*, v. 82: 2188-2191, May 5, 1960.

Research was undertaken to show how the existence of the second charge-transfer absorption band is in accord with the current model (VIS.05:001, Vol. II) for pyridinium iodide charge-transfer transitions. The close correspondence of the ΔE value, the difference between the transition energies for the 2 bands, for 1-methylpyridinium iodide in chloroform to the ΔE value

expected for production of an iodine atom is evidence for the charge (electron)-transfer nature of the excitation in the pyridinium iodide.

2231

Wisconsin U. Dept. of Chemistry, Madison.

HYDROGEN BONDING STUDIES. II. THE ACIDITY AND BASICITY OF SILANOLS COMPARED TO ALCOHOLS, by R. West. May 28, 1959, 15p. incl. diagrs. table, refs. (AFOSR-TN-59-473) (AF 49(638)285) AD 215716; PB 142157
Unclassified

Also published in *Jour. Amer. Chem. Soc.*, v. 81: 6145-6148, Dec. 5, 1959.

The hydrogen bonding acidity and basicity of some silanols and carbinols has been determined by the measurement of O-H stretching infrared band shifts upon admixture with the bases ether and mesitylene, and the acid phenol, respectively. The silanols studied are much more strongly acidic, but only slightly less basic, than the carbinols with analogous structure. The results for the silanols are discussed in terms of a model with strong π -bonding from oxygen to silicon involving only 1 of the 2 unshared electron pairs on the silanol oxygen. Intermolecular association of silanols was also studied by infrared spectroscopy. Trimethyl- and triethylsilanol are somewhat more highly associated than the corresponding carbinols, and the hydrogen bonds formed between silanol molecules appear to be decidedly stronger than those involving alcohols.

2232

Wisconsin U. Dept. of Chemistry, Madison.

NATURE OF π -BONDING FROM OXYGEN TO SILICON IN ORGANOSILICON COMPOUNDS, by R. H. Baney, K. J. Lake and others. Dec. 8, 1959 [1]p. incl. table, refs. (AFOSR-TN-59-741) (AF 49(638)285) AD 229578
Unclassified

Also published in *Chem. and Indus. (London)*, No. 36: 1129-1130, Sept. 5, 1959.

It is thought that the π bonding in silanols involves only 1 of the 2 unshared electron pair on the oxygen:
 $R_3Si-\ddot{O}-H \leftrightarrow R_3Si=\ddot{O}-H$. Basicity measurements are conducted on alkoxysilanes, siloxanes, and ethers with analogous structures. The following interpretations are presented: (1) $d\pi-p\pi$ bonding takes place in all of the silicon-oxygen compounds; (2) in alkoxysilanes and silanols the π -bonding is of the type described above, involving only 1 unshared pair on oxygen; and (3) in siloxanes, where 2 silicon atoms are bonded to each oxygen, both pairs of electrons on oxygen are involved in partial π -bonding: $R_3Si-\ddot{O}-SiR_3 \leftrightarrow R_3Si=O=SiR_3$.

2233

Wisconsin U. Dept. of Chemistry, Madison.

HYDROGEN BONDING STUDIES. IV. ACIDITY AND BASICITY OF TRIPHENYLHYDROXY COMPOUNDS OF GROUP IV_B ELEMENTS AND THE QUESTIONS OF PI-BONDING FROM OXYGEN TO METALS, by R. West and R. H. Baney. Dec. 8, 1959 [16]p. incl. diagr. table, refs. (AFOSR-TN-59-1207) (AF 49(638)285) AD 229577; PB 144865 Unclassified

Also published in Jour. Amer. Chem. Soc., v. 82: 6269-6272, Dec. 21, 1960.

The acidity and basicity as hydrogen bond donors and acceptors was measured for the compounds Ph_3MOH , where $\text{M} = \text{C}, \text{Si}, \text{Ge}, \text{Sn}$ and Pb . The trends in acidity and basicity in these compounds indicate that dative pi-bonding from oxygen to M is strong in Ph_3SiOH , weaker in Ph_3GeOH , and negligible in the other 3 compounds. A linear relationship was found between νOH and the electronegativity of M , for these and related hydroxyl compounds. (Contractor's abstract)

2234

Wisconsin U. Dept. of Physics, Madison.

ON THE MECHANISM OF THE SMALL ANGLE X-RAY SCATTERING FROM COLD WORKED METALS, by R. H. Neynaber, W. G. Brammer, and W. W. Beeman. [1959] [6]p. incl. diagrs. (AF 18(600)698) Unclassified

Presented at meeting of the Small Angle X-Ray Conf., Kansas City, Mo., Sept. 23-25, 1958.

Published in Jour. Appl. Phys., v. 30: 656-661, May 1958.

The characteristic small angle x-ray scattering from

cold worked polycrystalline foils of Cu , Al , and Ni is found to appear immediately when the foil is stretched in the x-ray beam at liquid air temperature. The scattering at a fixed angle is a reversible function of foil temperature as long as recrystallization temperatures are not exceeded. The temperature dependence is about twice that expected from the Debye temperature factor of an average Bragg reflection. It is postulated that the small angle scattering is the result of 2 successive Bragg reflections from 2 slightly misoriented subgrains of the same grain. The small angle scattering is found to be polarized. This can be understood only on the double Bragg scattering model. The double Bragg model was suggested by our observation of occasional isolated small angle peaks from annealed foils. These have unusual characteristics which quickly eliminate any possible single scattering source. They are double scattering from 2 large annealed grains which sometimes accidentally satisfy all the orientation requirements. (Contractor's abstract)

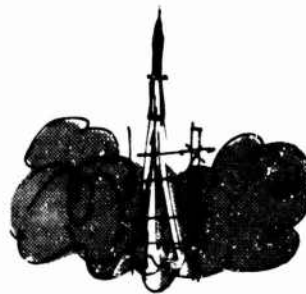
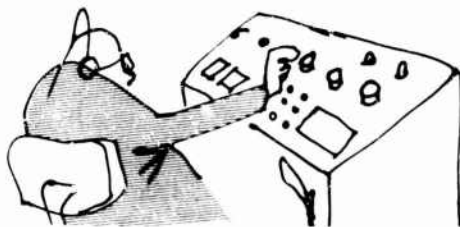
2235

Wisconsin U. [Dept. of Physics] Madison.

DOUBLE BRAGG SCATTERING IN COLD-WORKED METALS, by M. B. Webb and W. W. Beeman. [1959] [7]p. incl. diagrs. tables, refs. (AF 18(600)698) Unclassified

Published in Acta Metall., v. 7: 203-209, Mar. 1959.

The small-angle x-ray scattering from cold-worked metals is examined in terms of a double Bragg scattering mechanism. The intensity and angular distribution of the scattering expected from this mechanism are calculated and found to be in accord with experiment. It is shown that this mechanism should give a strongly polarized scattered flux at small angles and that the strong electric vector should be radial in the detecting plane. The polarization of the scattered flux was measured and found in agreement with these predictions. It is concluded that the double Bragg process and not density fluctuation scattering is responsible for most of the observed small-angle scattering. (Contractor's abstract)



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Yale U., New Haven, Conn.

PROCEEDINGS OF THE FIRST NATIONAL BIOPHYSICS CONFERENCE, Columbus, Ohio (U.S.A.) (Mar. 4-6, 1957), ed. by H. Quastler and H. J. Morowitz. New Haven, Yale University Press, 1959, 756p. incl. illus. diagrs. tables, refs. (AFOSR-5146) (AF 49(638)-7) Unclassified

This is a partial record of the First National (U.S.A.) Conference on Biophysics and is intended to acquaint a wide public with the present state of biophysical research in this country. The volume consists of 214 articles of papers submitted by invitation of the Program Committee or editors, papers submitted by authors and selected by the editors, and all abstracts which were submitted for presentation at the conference. It represents a composite view of the frontiers of biophysics. The topics are mainly in the fields of biology and medicine pertaining to application of physicists' methods and instruments to biologists' problems. After an introduction of 3 papers, the remaining papers and abstracts are arranged by topics under Part I (physical biology) and Part II (medicine). Subject and author indices are provided.

2237

Yale U. [Dept. of Mathematics] New Haven, Conn.

ON THE MAXIMALITY OF VANISHING ALGEBRAS, by A. B. Simon. [1959] [4]p. (AF 18(600)1127) Unclassified

Published in Amer. Jour. Math., v. 81: 613-616, July 1959.

Let G be a locally compact abelian group, μ the Haar measure of G , L^1 the usual convolution algebra, S a subset of G , and L_S the set of all functions the supports of which lie in S . If G is the real line and $S = (0, \infty)$, then as was proven by J. Wermer, L_S is the maximal.

The following theorem is proven. Let S be a measurable subsemigroup of G . If L_S is a maximal proper closed subalgebra of L^1 , then G is (continuously isomorphic with) either a discrete subgroup of the reals or the real line itself (with S mapping onto the non-negative part). The proof is based on a theorem concerning Hölder groups which is due to F. B. Wright (Duke Math. Jour., v. 24: 567-571, 1957) and on the following remarks. Let H be a measurable semigroup contained in G such that L_H is a maximal proper closed subalgebra of L^1 . Then (1) $H \cap (-H) = \{0\}$; (2) there is a maximal subsemigroup F_0 of the group G such that $L_{F_0} = L_H$ and $F_0 \cap (-F_0) = \{0\}$.

2238

Yale U. [Dept. of Mathematics] New Haven, Conn.

COMPOSITION ALGEBRAS AND THEIR AUTOMORPHISMS, by N. Jacobson. [1959] 26p. incl. refs. (AFOSR-TN-59-1117) (AF 49(638)110) AD 239513 Unclassified

Also published in Rend. Circ. Matem. Palermo, Series II, v. 7: 55-60, Jan.-Apr. 1958.

Automorphisms and groups of automorphisms of composition algebras are studied. Composition algebras are the algebras arising from quadratic forms which permit composition. These algebras are mainly quaternion algebras and Cayley algebras. The problem of determining the quadratic forms which permit composition (Hurwitz's problem) is solved for the case of characteristic not 2. The analysis of the composition algebras is essential for the study of their automorphisms. The structure of the group of automorphisms of an arbitrary Cayley algebra of characteristic not 2 is studied. Simple generators are obtained and the subgroups determined, giving fixed elements of a quaternion subalgebra or a quadratic subalgebra. An analogue is proved for Cayley algebras of the theorem that the automorphisms of a central simple associative algebra are all inner. (ASTIA abstract)

2239

[Yale U. Dept. of Mathematics] New Haven, Conn.

SOME GROUPS OF TRANSFORMATIONS DEFINED BY JORDAN ALGEBRAS. I, by N. Jacobson. [1959] [18]p. incl. refs. (AFOSR-TN-59-1118) (AF 49(638)110) Unclassified

Also published in Jour. Reine Angew. Math., v. 201: 178-195, 1959.

The definition of the groups and Lie algebras in the general case and their determination for special Jordan algebras with some restrictions on the base field are presented. The theory of generic minimum polynomials for arbitrary strictly power associative algebras is used as a starting point and from it are obtained the main properties needed in the sequel. The case of central simple Jordan algebras is discussed in the 2nd part. The generic minimum polynomials for these are derived and some further essential properties established. In the last section the results are utilized to obtain similar ones for Lie algebras and to obtain the known structure of orthogonal groups in 4 dimensional spaces relative to quadratic forms with square discriminants.

2240

Yale U. [Dept. of Mathematics] New Haven, Conn.

[FUNCTIONAL AND CLASSICAL ANALYSIS]

AIR FORCE SCIENTIFIC RESEARCH

by E. Hille. Final rept. [1959] 2p. (AFOSR-TR-59-158) (AF 49(638)153) Unclassified

This contract served as the economic backbone of the Special Program in Analysis at Yale during the academic years 1957-1959. The present paper reports briefly the visitors and students contributing to the research and a list of 6 publications resulting from the work of two of the visiting students.

2241

Yale U. [Dept. of Mathematics] New Haven, Conn.

SPECTRAL REPRESENTATION OF CERTAIN SEMI-GROUPS OF OPERATORS, by C. Ionescu Tulcea. [1959] [15]p. Incl. refs. (AF 49(638)153) Unclassified

Published in Jour. Math. and Mech., v. 8: 95-109, Jan. 1959.

Let G be a locally compact group, S a locally compact semi-group in G for which every non-vold open set in S has positive Haar measure. A character on S is a continuous complex valued function $\chi(\neq 0)$ which satisfies $\chi(s)\chi(t) = \chi(st)$ for every $s, t \in S$. Let E be the collection of characters endowed with the topology of uniform convergence on compact sets. For any locally bounded function $r(s) \geq 0$, defined on S , let $E(r)$ be the subset of E for which $|\chi(s)| \leq r(s)$. It is shown that $E(r)$ is locally compact and also gives sufficient conditions under which E is locally compact. The principal result of the paper concerns the integral representation of semi-groups of normal operators (not necessarily bounded) which act on a Hilbert space X . Let $\{U_s; s \in S\}$ be a set of normal operators on X which satisfy the conditions: (1) $U_{st} \subset U_s U_t$; (2) U_s and U_t commute; (3) $(U_s x|y)$ is continuous for every $x \in D(U_s)$ and $y \in X$. (In the case where the U_s are not bounded operators, more conditions are required on S .) Then there exists a unique Hermitian spectral family $\{\mu_{x,y}; x,y \in X\}$ on E such that $(U_s x|y) = \int E\chi(s) d\mu_{x,y}(\chi)$. In case the operators are all bounded, integration over E may be replaced by integration over an $E(r)$. Math. Rev. abstract)

2242

Yale U. [Dept. of Mathematics] New Haven, Conn.

SOME REMARKS ON COMMUTATIVE ALGEBRAS OF OPERATORS ON BANACH SPACES, by D. A. Edwards and C. T. Ionescu Tulcea. [1959] [11]p. (AF 49(638)-153) Unclassified

Published in Trans. Amer. Math. Soc., v. 93: 541-551, Dec. 1959.

A series of propositions are given in 4 parts concerning commutative algebras of operators on a Banach space

and more especially commutative algebras of scalar operators. (1) As an introduction, various results on spectral families of measures are described. (2) Let A be a nonempty bounded subset of X and suppose that $T \in \mathcal{B}(X, X)$ is an operator such that: (i) $TU_x = U_x T$ for all $f \in C(Z)$ and $x \in A$; (ii) $(Tx)_{x \in A} \in \mathcal{B}(Z, A)$. Then there is a function $g \in L^1(Z, A)$ such that: (j) $\|g\| = M(3) \|T\|$; (jj) $U_x = Tx$ for every x belonging to the closed linear space \mathcal{M} spanned by $U_{x \in A} \mathcal{B}(Z, \{x\})$. This is a generalization of a theorem due to W. G. Bade. (3) It is shown that under certain conditions, an algebra of scalar operators can be identified with a von Neumann algebra. Thus it is possible to reduce many results concerning algebras of scalar operators or σ -complete boolean algebras of projections, in Banach spaces, to corresponding results in Hilbert spaces. (4) Various remarks on spectral families of measures are made.

2243

Yale U. [Dept. of Mathematics] New Haven, Conn.

SOME THEOREMS ON FOURIER COEFFICIENTS, by W. Rudin. [1959] [5]p. (F 49(638)153) Unclassified

Published in Proc. Amer. Math. Soc., v. 10: 855-859, Dec. 1959.

The trigonometric polynomials with coefficients ± 1 is considered. Theorem I: There exists a sequence $\{\epsilon_n\}$ ($n = 1, 2, 3, \dots$), with $\epsilon_n = \pm 1$, such that
$$\sum_{n=1}^N \epsilon_n e^{in\theta} < 5N^{1/2}, \quad (0 \leq \theta < 2\pi; N = 1, 2, 3, \dots).$$

Shapiro's proof for this theorem is given. Consider p and q will always denote conjugate exponents. For

$1 \leq p < \infty$, L^p denotes the usual Lebesgue space of complex functions on the unit circle. L^1 is the space of all essentially bounded measurable functions on the circle.

The Fourier coefficients of any $f \in L^1$ will be denoted by $\hat{f}(n) = \frac{1}{2\pi} \int_{-\pi}^{\pi} f(e^{i\theta}) e^{-in\theta} d\theta$, ($n = 0, \pm 1, \pm 2, \dots$). Theorem II: Suppose $1 < p \leq 2$, and suppose there is a constant A such that $|F(z)| \leq A|z|^{q/2}$ near the origin. Then F maps L^p into L^2 . Theorem III: Suppose $1 \leq p \leq 2$. If $|F(z)| = A|z|^{2/p}$ near the origin, then F maps L^q into L^q . When it is restricted to even functions F , Theorem I can be used to show that Theorem III states a condition which is necessary as well as sufficient. Thus the following Theorem IV holds: Suppose $1 \leq p < \infty$, F is an even function, and $|z|^{-2/p} |F(z)|$ is not bounded near the origin. Then there is a continuous function f on the circle to which corresponds no $g \in L^q$ with $\hat{g} = \hat{f}$.

2244

Yale U. [Dept. of Mathematics] New Haven, Conn.

A CLASS OF SINGULAR INTEGRALS, by D. A. Edwards. [1959] [16]p. (AF 49(638)153) Unclassified

Published in Proc. London Math. Soc., v. 9: 161-176, 1959.

Let x denote a mapping of finite or infinite real linear interval I into a Banach space X over the real or complex field. For each compact interval $[a, b] \subseteq I$, let $E(a, b; x)$ be defined as the set of all finite sums of the

form $\sum_{j=1}^p x(t_j) - x(t_{j-1})$, in which $a \leq t_1 < t_2 < \dots$

$< t_{2p} \leq b$. Let $E(I; x)$ denote the union of $E(a, b; x)$ for all $[a, b] \subseteq I$. The class of mappings x for which $E(I; x)$ is bounded is denoted by $\mathcal{D}(I)$, and that for which $E(I; x)$ is conditionally weakly compact by $\mathcal{B}(I)$. The space of scalar-valued functions of bounded variation on I , with the usual norm, is denoted by $BV(I)$. The author shows first that if V denotes the mapping from X^* into the space of scalar-valued functions on I whose value at $x^* \in X^*$ is $x^*(x(\cdot))$, then $x \in \mathcal{D}(I)$ if and only if $VX^* \subseteq BV(I)$ and $x \in \mathcal{B}(I)$ if and only if V is a weakly compact operator from X^* into $BV(I)$. The singular integral theorem is then as follows. Let $I = [c, d]$ be a closed interval of \mathbb{R} and $\{\phi_n\}$ a sequence of scalar-valued functions defined on I^2 with $\phi_n(t, \cdot)$ Lebesgue integrable over I for

$n = 1, 2, 3, \dots$, $t \in I$. Let $x \in \mathcal{B}(I)$, let $J_n(x; t)$ denote the Bochner integral $\int_c^d \phi_n(t, u)x(u)du$, and let $\Phi(t, v) = \text{sign}(v - t) \int_t^v \phi_n(t, u)du$ for $v, t \in I$. The following 3 conditions on the sequence $\{\phi_n\}$ are then shown to be equivalent: (i) $J_n(\xi, t) \rightarrow \frac{1}{2}(\xi(t - 0) + \xi(t + 0))$ ($c < t < d$) as $n \rightarrow \infty$ for each $\xi \in BV(I)$; (ii) $J_n(x, t) \rightarrow \frac{1}{2}(x(t - 0) + x(t + 0))$ ($c < t < d$) strongly as $n \rightarrow \infty$ for each $x \in \mathcal{B}(I)$; (iii) for each fixed interior point t of I , $\Phi_n(t, v) \rightarrow \frac{1}{2}$ boundedly for $t < v \leq d$ and also boundedly for $c \leq v < t$ as $n \rightarrow \infty$. When these conditions hold the convergence in (i) takes place uniformly (for each fixed $t \in (c, d)$) over every conditionally weakly compact subset K of $BV(I)$. As an application, the real-valued functions ξ on I^2 of bounded Fréchet variation and bounded variation in each variable separately are characterized as those for which $x \in \mathcal{D}(I)$ with $x(t) = \xi(t, \cdot)$, $t \in I$.

2245

Yale U. [Dept. of Mathematics] New Haven, Conn.

ON A CLASS OF OPERATORS OCCURRING IN THE THEORY OF CHAINS OF INFINITE ORDER, by C. Ionescu Tulcea. [1959] [10]p. incl. refs. (AF 49(638)153) Unclassified

Published in Canad. Jour. Math., v. 11: 112-121, 1959.

Let T and E be measurable spaces. If x is in E let u_x be a mapping of T into T . If t is in T and if A is a measurable subset of E , suppose that $p(t, A)$ defines a probability measure for fixed t , and define Uf , for f bounded and measurable on T , by $(Uf)(t) = \int_E p(t, dx)f(u_x(t))$. Under supplementary hypotheses, ergodic properties of the sequence of powers of U are proved which contain various previous results proved in studies of chains of infinite order by Onicescu and Mihoc (Bull. Sci. Math., v. 59: 174-192, 1935), and later writers. Under suitable restrictions, with T the class of non-positive integers, it is shown that p is the transition function of a stationary mixing stochastic process, for which a form of the central limit theorem is stated. (Math. Rev. abstract)

2246

Yale U. Dept. of Mathematics, New Haven, Conn.

ON THE INVERSE FUNCTION THEOREM IN BANACH ALGEBRAS, by E. Hille. Apr. 1959, 9p. (AFOSR-TN-59-330) (AF 49(638)224) AD 213651; PB 146450 Unclassified

Also published in Bull. Calcutta Math. Soc., (Golden Jubilee Commemoration): 65-69, 1958-1959.

A proof is given of the inverse function theorem formulated for Frechet analytic functions with domain and range in a Banach algebra. A complex parameter α is introduced in the function, and the inverse function is obtained as a power series in α . The procedure makes it possible to use Cauchy's method of *Calcul des Limites* for the convergence proof.

2247

Yale U. Dept. of Mathematics, New Haven, Conn.

AN APPLICATION OF PRÜFER'S METHOD TO A SINGULAR BOUNDARY VALUE PROBLEM, by E. Hille. [1959] [12]p. incl. table. (AF 49(638)224) Unclassified

Published in Math. Zeitschr., v. 72: 95-106, 1959.

It is known that under certain conditions the operator $b(x)d^2/dx^2$ subject to the boundary condition $y(0) = 0$ has pure point spectrum $0 < \lambda_0 < \lambda_1 < \lambda_2 \dots, \lambda_n \rightarrow \infty$ on $C[0, \infty]$. A modification of the polar coordinate is used here to prove 2 theorems on the order of growth of λ_n as a function of n . [1] If $b(x) = (x + 1)\omega(x)$, where (i) $\omega(x) > 0$, (ii) $\omega(x)$ is continuously differentiable and $\omega'(x) > 0$ for large x , and (iii) $J = \int_0^\infty |b(x)|^{-\frac{1}{2}} dx < \infty$; then $\lambda_n = (\pi n/J)^2 [1 + o(1)]$ as $n \rightarrow \infty$. [2] Suppose that (i) and (ii) hold, but that instead of (iii) it is required that (iv) for every $\epsilon < 0$ and $C > 1$ there is an $x(\epsilon, C)$ such

that $\omega(x) < \omega(y) < (1 + \epsilon)\omega(x)$ when $x(\epsilon, C) \leq x < y < Cx$,

(v) $\int_0^\infty x[b(x)]^{-1} dx < \infty$, and (vi) there is an integer

$p \geq 1$ such that $\limsup [\inf\{\omega(x)\}^{\frac{1}{p}} [L_p(x)]^{-1} \int_0^x (1 + s)^{-1} [\omega(s)]^{-\frac{1}{p}} ds = \mu_p [\beta_p]$, where $L_p(x) = \log x \log_2 x \dots \log_p x$, $\log_p x$ is the p times integrated logarithm, and $1 \leq \beta_p \leq \mu_p < \infty$ except for $p = 1$ when $1 < \beta_1$ is required. Then $\lambda_n = \rho_n^2 \omega[L_p^{-1}(\sigma_n)]$ where $\rho_n > \frac{1}{2}$ and tends to $\frac{1}{2}$ as $n \rightarrow \infty$, and

L_p^{-1} is the inverse function of L_p . The limits of indeterminacy of σ_n are $2\pi\mu_p^{-1} \leq \liminf \sigma_n = \limsup \sigma_n = 2\pi\beta_p^{-1}$ for $p > 1$. For $p = 1$, μ_p^{-1} is replaced by

$(\mu_1 + 1)^{-1}$ and β_p^{-1} by $(\beta_1 - 1)^{-1}$.

2248

Yale U. [Dept. of Physics] New Haven, Conn.

[BROADENING OF SPECTRAL LINES PRODUCED BY THE IONS OF A PLASMA] Elargissement des raies spectrales produites par des ions dans un plasma, by M. B. Lewis and H. Margenau. [1959] [10]p. incl. diagrs. tables. [AF 18(603)15] Unclassified

Also published in Internat'l. Colloquium on the Optical and Acoustical Properties of Compressed Fluids and Molecular Interactions, Bellevue (France) (July 1-6, 1957), CNRS, Paris, 1959, p. 283-292.

For abstract see item no. YAL.08:005, Vol. II.

2249

Yale U. [Dept. of Physics] New Haven, Conn.

[THEORETICAL INTERPRETATION OF BAND SATELLITES INDUCED BY PRESSURE] Essais d'interprétation théorique des bandes satellites induites par la pression, by H. Margenau and L. Klein. [1959] [12]p. incl. diagrs. refs. [AF 18(603)15] Unclassified

Published in Internat'l. Colloquium on the Optical and Acoustical Properties of Compressed Fluids and Molecular Interactions, Bellevue (France) (July 1-6, 1957) CNRS, Paris, 1959, p. 283-292.

A quantum mechanical interpretation of pressure-induced band satellites in terms of interaction energy of oriented van der Waal molecules was made. Calculated splitting between E_0 and E_{+1} states is based on earlier results. The ΔE_{0+1} is given for Ar perturbation. The discussion is extended in terms of potential curves and possible transitions in emission and absorption.

2250

Yale U. [Dept. of Physics] New Haven, Conn.

CLUSTER APPROACH TO THE STATISTICAL THEORY OF LINE BROADENING BY IONS (Abstract), by H. K. Wimmel and M. B. Lewis. [1959] [1]p. [AF 18-(630)15] Unclassified

Presented at meeting of the Amer. Phys. Soc., Milwaukee, Wis., June 18-20, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 318, June 18, 1959.

A general expression in terms of cluster integrals is derived for the field distribution function in a dilute gas, arbitrary particle fields and short-range interactions between these particles being assumed. The formula obtained reduces to Holtsmark's function for an idealized plasma containing ions whose interaction is neglected. By introducing a hard-sphere repulsion in this model and taking into account 1- and 2-particle cluster integrals only, the peak of the field distribution shifts toward a field strength that is smaller by a factor $\lambda = [1 - \{4\pi(\sqrt{2} - 1)D^3n/3\}]^{2/3}$, where D = radius of the hard-sphere potential, and n = particle density. For a certain range of variables (small fields, low ion densities) the new function is approximately a shifted Holtsmark distribution.

2251

Yale U. [Dept. of Physics] New Haven, Conn.

HYPERFINE STRUCTURE OF THE METASTABLE TRIPLET STATE OF HELIUM THREE, by J. A. White, L. Y. Chow and others. [1959] [2]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18-(603)15], National Science Foundation, and Office of Naval Research) AD 241029 Unclassified

Published in Phys. Rev. Ltrs., v. 3: 428-429, Nov. 1, 1959.

The frequency difference at zero magnetic field between the levels $(3/2, -1/2)$ and $(1/2, -1/2)$ of the state $(1s2s, {}^3S_1)$ was measured by the atomic beam magnetic resonance method, which gave $\Delta\nu = (6739.7013 \pm 0.0004)$ mc/sec. Comparison between theory and experiment for the ratio of this value to that for the ${}^2S_{1/2}$ state of the He^{3+} ion (see item no. COU.19:009, Vol. II) gave a larger discrepancy than expected. This is attributed to inaccuracy in the computation of the relativistic correction for the atom.

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2252

Yale U. [Hammond Metallurgical Lab.] New Haven, Conn.

LATTICE IMPERFECTIONS IN METALLIC AND IONIC CRYSTALS [PART I] AND THE OPTICAL ABSORPTION EDGE OF INSULATING CRYSTALS AT LOW TEMPERATURES [PART II], by A. S. Nowick and R. G. Wheeler. Final rept. July 1, 1953-Feb. 28, 1959. Sept. 10, 1959, 12p. (AFOSR-TR-59-142) (AF 18(600)850) AD 226965; PB 143955
Unclassified

Part I: The interactions between point defects and dislocations were investigated. The observations of Gyulai and Hartly (Zeitschr. Phys. v. 51: 378, 1928), which showed an enhancement of the conductivity of rock salt by deformation, were confirmed and extended. The optical properties of alkali halides were studied. Measurements were made of the height of the F-band in NaCl crystals under x-irradiation as a function of irradiation dose and depth into the crystal. The results showed that coloration by x-rays occurs in 2 stages. The internal friction and elastic modulus of irradiated alkali halide crystals were investigated. An irradiation dose far below that required to produce an appreciable F-center concentration greatly increased the modulus and decreased the internal friction of a freshly deformed crystal; no change occurred in an annealed crystal. Pure gold was selected for a study of quench hardening phenomenon. The study led to the conclusion that the annealing probably occurs by means of self diffusion along dislocation lines. Part II: The electronic band structure of CdS was studied. The absorption lines were determined as a function of crystal thickness. Edge luminescence in CdS is being investigated.

2253

Yale U. [Sloane Physics Lab.] New Haven, Conn.

EFFECTS OF ATOMIC ELECTRONS ON p-p AND n-p SCATTERING II, by G. Breit. Apr. 3, 1959, 3p. (AFOSR-TN-59-369) (AF 18(600)771) AD 213861
Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 401-402, May 1, 1959.

The possibility that a screening effect, hitherto assumed to be small, may prove to be nonnegligible at low energies (≤ 10 mev) was theoretically discussed. Coulomb excitation of the molecular electrons and acceleration of the target atom are considered. These effects interfere with the employment of low energy data for p-wave anomaly detection and increase the relative importance of higher energy work.

2254

Yale U. [Sloane Physics Lab.] New Haven, Conn.

COMPENSATIONS IN ELECTRON EXCITATION

EFFECTS IN p-p AND p-n SCATTERING, by M. de Wit, C. R. Fischer, and W. Zickendraht. May 5, 1959 [12]p. (AFOSR-TN-59-486) (AF 18(600)771) AD 215779; PB 142158
Unclassified

Also published in Proc. Nat'l. Acad. Sci., v. 45: 1047-1052, July 1959.

An account is given of calculations for monopole, dipole and quadrupole Coulomb excitation. For each of the 3 multipoles the effects of the different channels were combined, and finally the incoherent contributions were added to the effects of the cross product terms on the coherent scattering. Employing the asymptotic expression $kr - \eta \ln 2kr - (L\pi/2) + \arg(L+1+i\eta)$ for the phase of the regular Coulomb function and 1 for its amplitude, the result was found to be zero. This indicates that the compensation of elastic and inelastic scattering effects present in the classical mechanics treatment carries over to some extent into the quantum mechanical problem. Separate action functions S_g, S_n are introduced for treating nucleon motion in the ground and n^{th} excited states as has previously been done for tracing correspondence principle connections in nucleon Coulomb excitation.

2255

Yale U. [Sloane Physics Lab.] New Haven, Conn.

VACUUM POLARIZATION AND SCREENING EFFECTS IN SCATTERING FROM HEAVY NUCLEI (Abstract), by G. Breit and S. Ohnuma. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Atomic Energy Commission under AT(30-1)1807)
Unclassified

Presented at Ninety-sixth annual meeting of the National Academy of Sciences, Washington, D. C., Apr. 27-29, 1959.

Published in Science, v. 129: 1282, May 1, 1959.

In order to facilitate geometry calibrations of p-p scattering experiments by scattering of protons by nuclei and as a matter of general interest, effects of the vacuum polarization (vp) have been calculated and compared with screening (sc) by electrons. In Uehling's approximation the vp appears as a superposition of Yukawa terms for which the scattering amplitude is expressible by means of the hypergeometric function suitable for computation and can be rearranged in series with Bessel functions of imaginary argument $K_n(x)$ in coefficients of incident momentum. This expansion is related to the classical orbit view shown to furnish a fair approximation. Classically the quantity x is the eccentricity of the orbit times half the minimum distance of closest approach times the reciprocal range constant of the potential. The vp scattering is obtained by superposing amplitudes for Yukawa potentials. The results can be represented approximately by a universal curve relating $Z_1 Z_2 / [E_{\text{lab}} \sin(\theta/2)]$, in usual notation, to the fractional

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change in the differential cross section. For $\theta = 10^\circ$ and energies 3 and 1.5 mev proton-argon scattering effects of $\sim 272\%$ and 0.166% , respectively, and for alpha-lead scattering at $\theta = 5^\circ$ and 21.95 mev, a 0.080% vp effect are found. In latter case sc effect is -0.6% . For p-Xe, 9 mev, 10° the sc effect is -0.28% , comparable with the vp effect. Precision tests of vp action for fundamental theory are complicated by presence of sc potential.

2256

Yale U. [Sloane Physics Lab.] New Haven, Conn.

CALCULATIONS ON THE PHOTO-DISINTEGRATION OF THE DEUTERON, by G. Breit. 1959 [12]p. incl. diagrs. refs. (Sponsored jointly by Air Force Office of Scientific Research under AF 18(600)771 and Office of Ordnance Research) Unclassified

Published in Proc. Internat'l. Conf. on Nuclear Forces and the Few-Nucleon Problem, University Coll., London (Gt. Brit.), July 8-11, 1959, New York, Pergamon Press, 1960, p. 311-322.

Preliminary measurements and calculations were made on the photo-disintegration of deuterons to test the views of nucleon-nucleon forces and electromagnetic properties of nucleons. An arrangement of the calculation is presented by means of which the inclusion of higher multipoles and changes in assumptions regarding potentials may be quickly taken into account. The arrangement is being programmed for an IBM 704. An amplitude method similar to that used in the nucleon-nucleon phase-shift analysis was used. Comparison with experiment showed the presence of systematic deviations at lower energies.

2257

Yale U. [Sloane Physics Lab.] New Haven, Conn.

METASTABILITY OF 2s STATES OF HYDROGENIC ATOMS (Addendum), by J. Shapiro and G. Breit. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)771] and Office of Ordnance Research) Unclassified

After the publication of an earlier paper (item no. YAL.04:023, Vol. II) attention has been called to related work by Spitzer and Greenstein (Astrophys. Jour., v. 114: 407, 1951), in which the probability of double photon emission to 2s states of hydrogenic atoms has been calculated for the case $Z = 1$. There is excellent agreement in the values obtained for the transition probability in the 2 papers, the value of Spitzer and Greenstein being 8.277 sec^{-1} and that in the earlier paper, $8.226 \pm 0.001 \text{ sec}^{-1}$. The latter publication goes somewhat beyond the earlier one in this connection

in the consideration of the Z dependence, of the accuracy of the results, and the discussion of the distinction between the double emission and cascade processes especially in connection with the Lamb shift.

2258

Yale U. [Sloane Physics Lab.] New Haven, Conn.

FORMATION OF MUONIUM (Abstract), by V. W. Hughes, A. Lurio and others. [1958] [3]p. incl. table. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Atomic Energy Commission and Office of Naval Research) Unclassified

Presented at Conf. on Physics of Electronics and Atomic Collisions, New York U., N. Y., Jan. 27-28, 1958.

Plans to form and study muonium by slowing down μ^+ mesons in a gas are outlined. Muonium will be formed by the capture of an electron from a gas atom by a μ^+ meson. The capture cross section will be of order $\pi a_0^2 (\sim 9 \times 10^{-17} \text{ cm}^2)$ at muon velocities comparable to electron velocities in the atom, but muonium formed by such an energetic muon has sufficient energy to be ionized in a collision with a gas atom. At muon velocities sufficiently low so that muonium atoms formed will be stable against ionizing collisions, the capture process can be treated by the method of perturbed stationary states and the capture cross section may be several orders of magnitude less than πa_0^2 .

2259

Yale U. [Sloane Physics Lab.] New Haven, Conn.

MAGNETIC MOMENT OF HELIUM IN ITS 3S_1 METASTABLE STATE, by C. W. Drake, V. W. Hughes and others. [1959] [11]p. incl. diagrs. table, refs. (AFOSR-TN-59-16) [AF 18(600)1565] AD 208597 Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 29-Feb. 1, 1958.

Abstract published in Bull. Amer. Phys. Soc., Series II, v. 3: 7, Jan. 29, 1958.

Also published in Phys. Rev., v. 112: 1627-1637, Dec. 1, 1958.

The ratio of the electronic g_J value of He in its $1s2s, ^3S_1$ metastable state to the g_J of H in its ground state has been redetermined by the atomic beam magnetic resonance method using separated oscillating fields. At magnetic fields of about 540 and 575 gauss the transitions $\Delta m = \pm 1, \pm 2$ in He and $(F, m) = (1, 0) \rightarrow (1, -1)$ in H are

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observed at frequencies of approximately 1570 mc/sec and 1140 mc/sec, respectively. The natural line shapes for the separated oscillating fields method are obtained with spacings between the oscillating fields of both 4.2 cm and 2.2 cm. The experimental result is $g_J(\text{He}, {}^3S_1)/g_J(\text{H}, {}^2S_{1/2})|_{\text{exp}} = 1 - (23.3 \pm 0.6) \times 10^{-6}$, which agrees with an earlier measurement having an accuracy of 16 ppm, and also with the theoretical value $g_J(\text{He}, {}^3S_1)/g_J(\text{H}, {}^2S_{1/2})|_{\text{theor}} = 1 - (23.3 \pm 1.0) \times 10^{-6}$ obtained by Perl and Hughes, which was computed from the Breit equation for He with the addition of a term to represent the interaction of the anomalous spin magnetic moment of each electron with the external magnetic field. (Contractor's abstract)

2260

Yale U. [Sloane Physics Lab.] New Haven, Conn.

HYPERFINE STRUCTURE IN THE METASTABLE

TRIPLET STATE OF He^3 (Abstract), by J. A. White, C. W. Drake, and V. W. Hughes. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], National Science Foundation, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 10, Jan. 28, 1959.

The hyperfine structure of the 2^3S_1 state of the He^3 atom has been determined by the atomic beam magnetic resonance method. Earlier measurements had indicated that the frequency corresponding to the $\Delta m_F = 0$ transition between the $(F, m_F) = (3/2, -1/2)$ and the $(F, m_F) = (1/2, -1/2)$ levels should be a minimum, and hence only quadratically field dependent, at a magnetic field of about 800 gauss. This minimum frequency was located and accurately measured. The hyperfine splitting, which according to the Breit-Rabi formula is exactly $3/(2\sqrt{2})$ times the minimum frequency, is 6739.7022 mc/sec with an estimated uncertainty of 1 part in 10^7 . The present value is in agreement with the earlier value which had an uncertainty of 7 parts in 10^6 .

2261

Yale U. [Sloane Physics Lab.] New Haven, Conn.

HYPERFINE STRUCTURE OF $\text{He}^4-\mu^-e^-$ (Abstract), by V. W. Hughes and S. Penman. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 80, Jan. 28, 1959.

The availability of polarized muons and of a method for their detection may make possible a measurement of the hyperfine structure of the ground state of the system consisting of a He^4 nucleus, a negative muon, and an electron; hence it is useful to consider the theoretical value of this hfs splitting. The μ^- meson will be bound closely to the He^4 nucleus as in a mu-mesic atom, and the electronic wavefunction will be approximately hydrogenic. Hence in the lowest approximation the hfs splitting, ΔW , (which is inverted) is given by the Fermi formula and has the same value as for muonium. The principal corrections to this approximation arise from the finite size of the $\text{He}^4-\mu^-$ atom, the reduced mass correction, and the anomalous magnetic moments of electron and muon. The expression $\Delta W = (\Delta W)_F (1 - 3 m_e/2 m_\mu) (1 + m_e/m_{\text{He}})^{-3} (1 + \alpha/2\pi)^2 = (4492 \pm 4) \text{ mc/sec}$ gives these correction factors in the order listed. Higher order corrections arising from radiative processes, a more accurate treatment of muon and electron wavefunctions, the finite size of the He^4 nucleus, and recoil are omitted to the accuracy quoted.

2262

Yale U. [Sloane Physics Lab.] New Haven, Conn.

SEARCH FOR LOW-FREQUENCY ZEEMAN TRANSITIONS IN MUONIUM (Abstract), by D. McCollm and V. W. Hughes. [1959] [1]p. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Atomic Energy Commission, and Office of Naval Research) Unclassified

Presented at meeting of the Amer. Phys. Soc., New York, Jan. 28-31, 1959.

Published in Bull. Amer. Phys. Soc., Series II, v. 4: 82, Jan. 28, 1959.

Several experiments on the depolarization of muons in gases have suggested the possibility that $(\mu^+ - e^- \text{ bound state})$ is formed when positive muons are stopped in nitrous oxide gas. An experiment is in progress to observe a low-frequency Zeeman transition in muonium and hence to provide a more specific test of muonium formation. A maximum change in events counting rate of 40% between the rf-on and rf-off conditions is predicted. One run has been made and no effect due to the rf was observed either in N_2O (~3% statistics) or in A (~5% statistics). Since muonium will act chemically much like a hydrogen atom, there is considerable question as to whether it will remain free in the gas during its lifetime since it will make many collisions with gas

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molecules. In particular an O_2 impurity could result in the formation of muonium oxide (a^2 ground state) and an NO impurity could lead to a change in the hfs state due to an exchange collision.

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Yale U. [Sloane Physics Lab.] New Haven, Conn.

ELECTRON MAGNETIC MOMENT AND ATOMIC MAGNETISM, by V. W. Hughes. [1959] [28]p. incl. diagrs. tables, refs. (Sponsored jointly by Air Force Office of Scientific Research under [AF 18(600)1565], Office of Naval Research, and National Science Foundation)

Unclassified

Published in Recent Research in Molecular Beams, New York, Academic Press, 1959, p. 65-92.

Theoretical and experimental values of electron spin magnetic moment and the atomic electronic magnetic moments (g_j values) were compiled for various isotopes. Diagrams for various apparatuses used in experimental measurements are given.

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Yale U. Sloane Physics Lab., New Haven, Conn.

MULTIPLIET STRUCTURE OF EXCITONS IN CdS, by R. G. Wheeler. May 1959 [8]p. incl. diagrs. refs. (AFOSR-TN-59-526) (AF 49(638)503) AD 216260; PB 142266

Unclassified

Also published in Phys. Rev. Ltrs., v. 2: 463-465, June 1, 1959.

A description is given of the line absorption spectra near the absorption edge of single crystals at 4.2°K. The spectra are interpreted assuming an S-like conduction band and a p-like valence band, and deriving optical selection rules from the symmetry properties associated with these bands.

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Yale U. Sloane Physics Lab., New Haven, Conn.

ZEEMAN SPLITTING OF EXCITON LINES IN CdS, by R. G. Wheeler and J. O. Dimmock. Oct. 1959 [11]p. incl. diagrs. table, refs. (AFOSR-TN-59-764) (AF 49(638)503) AD 226222; PB 143957

Unclassified

Also published in Phys. Rev. Ltrs., v. 3: 372-374, Oct. 15, 1959.

The 2-fold splitting of 3 absorption lines in CdS in the wavelength region greater than 4840Å is reported. All other lines observed do not split in fields up to 19 kgauss. The g values of the lines are dependent upon the orientation of the magnetic field with respect to the c axis of the crystal. Also observed was a small shift in the mean position of the split lines which is approx quadratic with magnetic field strength.

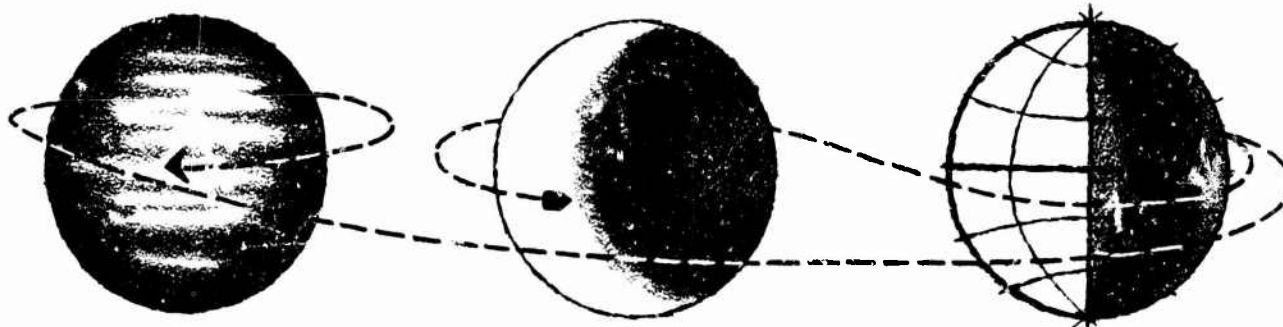
2266

Yeshiva U. Graduate School of Mathematical Sciences, New York.

NOTE ON THE PAIR DENSITY NEAR A WALL, by J. L. Lebowitz. [1959] 12p. incl. refs. (AFOSR-TN-59-953) (AF 49(638)753)

Unclassified

The asymptotic value is calculated of the conditional probability density $\rho_2(r_2, r_1)$ for finding a fluid particle at a point r_2 for in the interior of a fluid when it is known that there is a particle at r_1 in contact with the walls (rigid) of the container. This value is different from the well known expression for the asymptotic value of $\rho_2(r_2, r_1)$ when both r_2 and r_1 are in the interior of the fluid. The derivation presented is based on the virial theorem for total momentum fluctuations in an equilibrium system and makes use of the assumption that there are no long range correlations in a fluid. Application is made of the result to rederive simply the expression for the 2nd virial coefficient and the exact equation of state of a hard sphere gas in 1 dimension.



AIR FORCE SCIENTIFIC RESEARCH

2267

Zator Co., Cambridge, Mass.

A NEW METHOD FOR DISCOVERING THE GRAMMARS OF PHRASE STRUCTURE LANGUAGES, by R. J. Solomonoff. Apr. 1959, 13p. incl. diagrs. tables. (Rept. no. ZTB-124) (AFOSR-TN-59-110) (AF 49-638)376) AD 210390; PB 140705 Unclassified

A new method was devised for the discovery of the grammars of phrase structure languages. The method has applications in information retrieval, linguistics pattern discovery and a kind of mechanical translation. A technique is used that is similar to one described by Chomsky and Miller for discovering the grammars of finite state languages. In finite state languages, a phrase that forms a cycle may be successively repeated an arbitrary number of times in an acceptable sentence, because the insertion of that phrase does not change the state that exists at the point of insertion. In phrase structure languages, the corresponding entity that forms a cycle is an ordered pair of phrases. If the first phrase of such a pair be inserted before, and the second phrase be inserted after a suitable type of single phrase in an acceptable sentence, then the sentence will remain acceptable. The insertions may be repeated an arbitrary number of times, because the process does not change the phrase type of the single phrase. The set of all such cycles and higher order cycles that exist in a phrase structure language along with the insertion rules, constitute a complete grammatical description of the language. These cycles are discovered by a systematic process of deletion and reinsertion of phrases and pairs of phrases. A teacher on equivalent, is used to determine if the sentences resulting from the deletions and reinsertions are acceptable sentences. (Contractor's abstract)

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Zator Co., Cambridge, Mass.

THE NEXT TWENTY YEARS IN INFORMATION RETRIEVAL. SOME GOALS AND PREDICTIONS, by C. N. Mooers. Mar. 1959, 18p. incl. refs. (Rept. no. ZTB-121) (AFOSR-TN-59-245) (AF 49(638)376) AD 212225; PB 140835 Unclassified

Presented at Western Joint Computer Conf. on New Horizons with Computer Tech., San Francisco, Calif., Mar. 3-5, 1959.

Also published in Amer. Doc., v. 11: 229-236, July 1960.

Some of the history of retrieval machine development during the past 20 yr is sketched as background. At present, there are still no completely satisfactory machines for retrieval on large collections. Solution of the language problem in retrieval is currently somewhat ahead of machine development. Future develop-

ments are sketched. Work is already underway on the use of machines for the assignment of descriptors to the text, which is a crude kind of mechanical translation. Retrieval machines will soon be called upon to assist the customer in using a retrieval system by helping him to formulate his search requests. This assistance amounts to education of the customer. The notion of education by machine is extended to machine assistance in helping the customer to read the documents uncovered. It is shown how this process, when combined with work on mechanical translation, will lead to machines which can provide essays on any given subject upon request. Machines will become archival devices to store facts, not texts. Human-to-machine and machine-to-human communication will become very important. Information machines can be expected to become as numerous as computers now are. (Contractor's abstract)

2269

Zator Co., Cambridge, Mass.

THE MECHANIZATION OF LINGUISTIC LEARNING, by R. J. Solomonoff. Apr. 1959, 16p. (Rept. no. ZTB-125) (AFOSR-TN-59-246) (AF 49(638)376) AD 212226 Unclassified

Also published in Proc. Second Internat'l. Cong. on Cybernetics, Namur (Belgium) (Sept. 3-10, 1958), Namur, Association Internationale de Cybernetique, 1960, p. 180-193.

Some methods were obtained for the mechanization of linguistic learning, which is of interest in information retrieval, mechanical translation and linguistic analysis. Routines were devised for discovering the grammatical rules of certain elementary language types in a suitable training situation. One of the routines is for the discovery of the grammars of phrase structure languages, a problem that has not yet been satisfactorily dealt with. This method is an extension of techniques for the mechanization of inductive inference previously developed for solving problems in arithmetic learning. In as much as most of the English language appears to be describable as a phrase structure language (though it is not at all economical to express English grammar rules in this form), the above method may be of some importance in analysis of ethnic languages. In some idealized cases the problem of learning to translate languages is considered as a problem in discovering the grammar rules of a new type of generalized language. An example is shown in which learning to translate between 2 phrase structure languages is identical with discovering the grammar rules of a new kind of phrase structure language. (Contractor's abstract)

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Zator Co., Cambridge, Mass.

RESEARCH IN INDUCTIVE INFERENCE, by R. J.

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Solomonoff. Progress rept. for the year ending Mar. 31, 1959. May 1959, 12p. (Rept. no. ZTB-130) (AFOSR-TN-59-519) (AF 49(638)376) AD 216240; PB 142292
Unclassified

The concept of language was generalized to include patterns of many extremely diverse types. This will make it possible to apply inductive inference methods that were originally devised for simple phrase structure languages to more complex pattern types, such as arithmetic problems, transformational languages, and translation between pairs of phrase structure languages and transformational languages. Work was done on devising machines that will improve their own methods of operation. Work completed includes new methods for discovering the grammars of finite state languages and phrase structure languages, and methods for determining all possible phrase structures of an arbitrary sentence of a phrase structure language of known grammar. Important work was done on methods of discovering approximation languages. Routines of this type are not accurate all of the time but are useful for getting quick, approximate results. Just about all the basic theoretical work was done so that a machine to discover the grammars of phrase structure languages could be programmed. With what seems at present to be only a little more work, a machine could be made to discover translation rules between certain simple language pairs, and learn to work several kinds of arithmetic problems. However, such a machine would be very slow in learning, would ask a very large number of questions, and would often be unable to learn a pattern if a single error were made in giving examples to it. Work is now progressing on a unified method of overcoming these difficulties. (Contractor's abstract)

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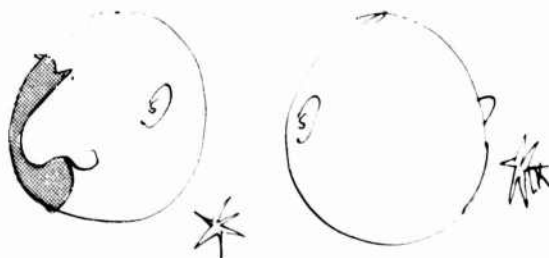
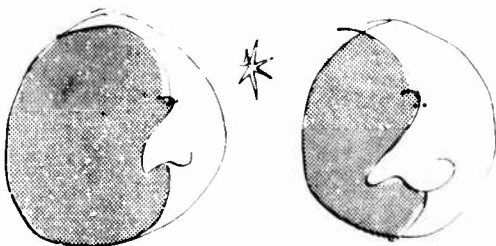
Zator Co., Cambridge, Mass.

ON MACHINES TO LEARN TO TRANSLATE LANGUAGES AND RETRIEVE INFORMATION, by R. J. Solomonoff. Progress rept. Oct. 1959, 17p. (Rept. no. ZTB-134) (AFOSR-TN-59-646) (AF 49(638)376) AD 228203; PB 161263
Unclassified

Presented at Internat'l. Conf. for Standards on a Common Language for Machine Searching and Transl., Cleveland, Ohio, Sept. 8-12, 1959.

Also published in Advances in Doc. and Library Sci., v. 3(Pt. 2): 941-953, 1961.

This paper discusses theoretical work which makes it possible for a machine to be programmed to learn to translate between 2 simple, synthetic languages, after it has been given a large set of correct examples in a suitable training situation. The limitations of the methods are discussed. A system is described in which a machine would learn to assign descriptors or other search indices to documents, after having been given a large set of documents and the search indices that have been assigned to them by humans. Some of the problems that must be solved before such a system can be realized are discussed. A unified method is proposed for resolving the difficulties of both the information retrieval and the mechanical translation routines. (Contractor's abstract)



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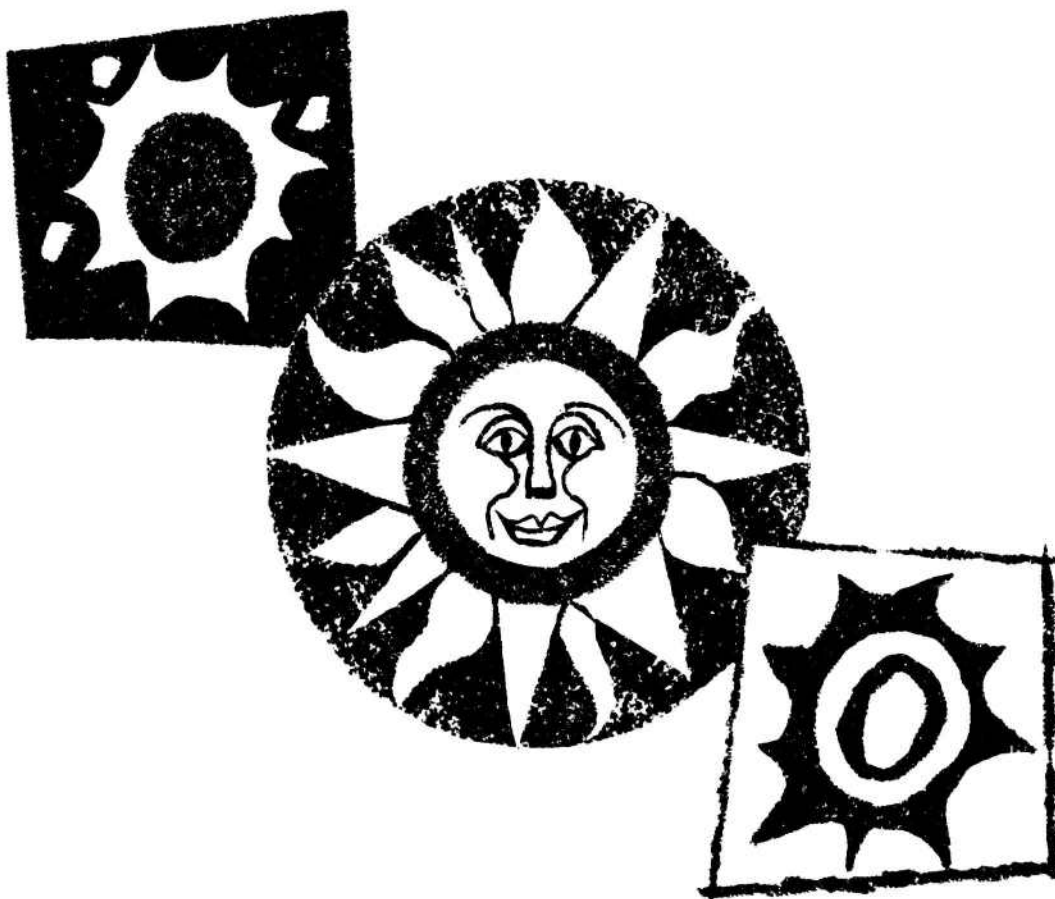
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473	2231	530	1687
474	236	531	1038
475	1632	533	1870
476	185	534	1806
477	1775	536	74
478	1776	537	75
479	850	538	1588
480	457	540	23
481	1208	541	891
482	1186	542	81
483	1480	543	780
484	32	544	1519
485	1656	545	324
486	2254	546	367
487	2118	547	114
488	581	548	127
489	989	549	799
490	1323	550	1216
491	1034	551	2151
492	1412	552	952
493	134	553	695
494	1266	554	921
495	1349	555	689
496	1777	556	585
496a	1778	557	829
496b	1779	558	830
497	315	559	831
498	489	560	839
499	736	561	565
500	1342	562	1035
501	1329	563	153
502	1542	564	417
503	1543	565	836
504	443	566	837
505	461	567	1767
506	1168	568	194
507	909	569	1190
508	285	570	535
509	1426	571	1835
510	2064	572	883
511	2040	573	884
512	1628	574	2137
513	27	575	2138
514	130	576	1350
515	1834	577	972
516	2147	579	1801
517	18	580	1399
518	1398	581	2159
519	2270	582	146
520	193	583	147
521	2179	584	706
522	2180	585	1337
524	246	586	1725
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714	262	775	1465
715	2060	776	1012
716	1944	777	781
717	686	778	782
719	1427	779	783
720	979	780	1614
721	286	781	784
722	2139	782	785
723	2140	783	1629
725	2160	784	1630
726	1939	785	1631
727	1734	786	892
728	1735	787	1013
729	1751	788	1196
730	1472	789	490
731	885	790	2120
732	1295	791	142
733	2161	792	451
734	1249	793	1413
735	2152	794	1414
736	2213	795	1400
737	1822	796	1401
738	1330	797	2203
739	953	798	475
740	980	800	1415
741	2232	801	1780
742	665	802	1781
743	441	803	382
744	406	804	954
745	370	805	1674
746	1742	806	1697
748	1380	807	442
749	1464	809	1345
750	1640	810	533
751	1641	811	2228
752	696	812	2229
753	1881	813	2230
754	462	814	637
755	463	815	638
756	1437	816	639
757	1438	817	640
758	923	818	749
759	1272	819	915
760	1432	820	19
761	664	821	13
762	541	822	156
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765	540	825	1424
766	251	826	1425
767	252	827	1615
768	253	828	1616
769	254	829	1617
770	1369	830	1618
771	912	831	1619
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840	860	898	1499
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842	2143	900	1967
843	641	902	1921
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852	1189	910	584
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855	1291	917	265
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857	316	920	5
858	320	921	1298
860	162	922	1239
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862	501	925	1660
863	502	926	1736
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879	991	946	431
880	1824	947	1061
881	2197	948	1968
882	62	949	586
883	409	950	931
884	248	951	120
885	470	952	621
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887	73	954	1889
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	969	77	1033 578
	970	1621	1034 330
	971	1622	1035 1193
	972	1623	1036 739
	973	1624	1037 622
	974	981	1039 740
	975	756	1040 982
	976	2124	1041 1218
	977	1300	1042 1788
	979	1743	1043 435
	980	737	1044 255
	981	738	1045 256
	982	180	1046 419
	983	1951	1047 344
	984	439	1048 263
	985	1446	1049 1544
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	990	172	1053 1548
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	992	804	1055 1550
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	997	1484	1060 1555
	998	1485	1061 1556
	999	1486	1062 2184
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1085	1764	1143	249
1086	420	1144	745
1087	421	1145	746
1088	422	1148	869
1089	423	1149	871
1090	424	1150	1851
1091	1072	1151	1664
1092	867	1152	232
1093	1727	1153	1796
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1097	684	1157	744
1099	2013	1159	1018
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1120	528	1180	1760
1121	1885	1181	243
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1126	767	1186	1999
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1129	743	1189	881
1130	1642	1190	64
1131	1643	1191	959
1132	266	1192	425
1133	791	1193	414
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	1214	858	1274 574
	1215	385	1275 119
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	1228	1558	1290 2133
	1229	1559	1291 491
	1230	1560	1292 1187
	1231	1561	1293 1881
	1232	1562	1294 803
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	1234	768	1296 1346
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1327	1192	45	2083
1328	1340	46	817
1329	2200	47	889
1331	1940	48	1490
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1333	69	51	2048
1334	24	52	98
1335	1665	54	483
1336	1371	55	1914
1337	1836	58	1299
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		60	890
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4	662	64	2073
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6	1032	66	1319
7	668	67	1905
8	1673	68	755
9	1224	69	870
10	1250	70	797
		71	793
11	573	72	1326
12	878	74	43
13	261		
14	779	75	674
15	1309	76	1298
16	99	77	887
17	1722	78	1025
18	30	79	678
19	1361	80	2225
21	661	81	1225
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26	2067	87	1334
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28	536	89	2061
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34	399	96	479
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36	872	97	863
37	397	98	675
38	2226	99	1367
39	1625	100	642
40	2172	101	1797
41	1068	102	510
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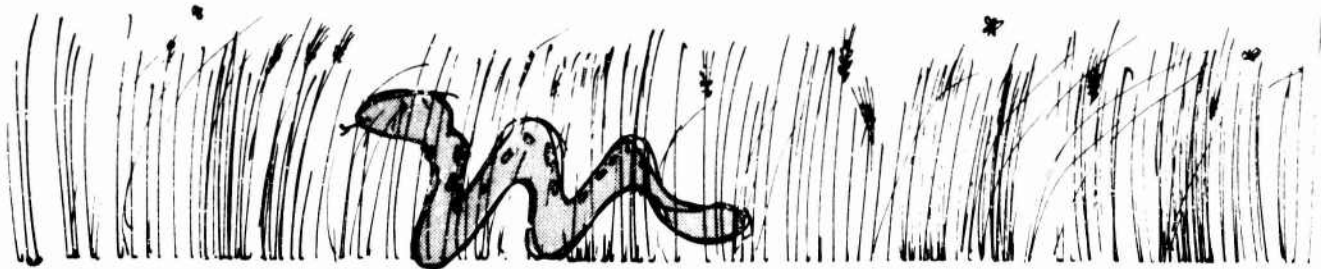
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	125	787		1455	
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	128	1379		85	
	131	292		53	
	132	1226		271	
	133	1955		366	
	134	1890		687	
	135	1897		2093	
	136	359		1451	
	137	669		478	
	138	2086		849	
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	158	2240		651	2145
	160	2082		1000	2071
	161	838		1001	538
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	164	90		1654	2035
	165	1441		1727	568
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	3505	1932		4120	1878
	3506	1521		4129	1571
	3507	1522		4155	95
	3561	1762		4156	96
	3563	1763		4159	1739
	3571	1003		4160	1740
	3588	1288		4208	1718
	3589	1289		4210	1719
	3642	1474		4289	1318
	3643	1475		4303	122
	3645	819		4397	244
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	3666	1933		4432	542
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	3844	1286		5041	1588
	3847	709		5146	2236
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